JPRS-UEQ-89-007
8 MAY 1989


# JPRS Report

# Science & Technology

## USSR: Engineering & Equipment

# Science & Technology
## USSR: Engineering & Equipment

*JPRS-UEQ-89-007* *8 May 1989*

CONTENTS

**Mechanics of Gases, Liquids, Solids**



**Industrial Technology, Planning, Productivity**



**Miscellaneous**

UDC 621.45.00.11.24:629.755

**Selection of the Most Efficient Dimensions and Operating Parameters of a Standardized Turbojet Engine for a Series of Subsonic Aircraft**
*18610054a Kazan IZVESTIYA VYSSHIKH UCHEBHYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA In Russian No 2, Apr-Jun 88 pp 67-71*

[Abstract of article by Ye.D. Stenkin, V.S. Kuzmichev, M.A. Morozov and O.M. Zhukov; submitted 27 Jun 87]

[Abstract] A cursory analytical study of the effect of turbojet engine dimensions on aircraft operation was conducted. Two models—a four-engine aircraft (9000 km range, capable of carrying 30 t) and a twin-engine aircraft (3000 km range, capable of carrying 20 t)—with different variants of the standard turbojet engine used were optimized for cruising flight in terms of the total mass of the aircraft and the specific fuel consumption in t/km. Using this analysis as a guide, the conceptual basis for a simultaneous optimization of size and performance of a standardized gas turbine engine is proposed; a few fundamental equations are written based on minmax principles. For optimization of more than two parameters, readers are directed to the article by A.N. Kovartsev in the monograph "Proyektirovaniye i dovodka aviatsionnykh gazoturbinnykh dvigateley" [Design and Testing of Aviation Gas Turbine Engines], Kuybyshev, KuAI, 1983. Figures 2, tables 2.

UDC 621.934.4.001.2.005:621.45

**On the Principle of Structural Adequacy in the Methodology of Design and Testing of Aviation Engines**
*18610054b Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 88 pp 75-79*

[Abstract of article by B.D. Fishbeyn; submitted 27 Apr 87]

[Abstract] In line with contemporary ideas about viewing human activities as a system, one of the most important methodological principles is that of the "adequacy" of its componentry. That principle (the composition of elements applicable to the materials, methods and control structure should be suitable to the composition of elements and structure of the object being developed) is applied to the development of a gas turbine engine as a concrete example. The design of a mathematical model of the processes going on in the engine is examined. The various ways of organizing the design and building (which brigades should be responsible for which subsystems of the entire engine project) are discussed. Two variant organizational schemes are outlined, one along traditional lines and the other with several layers of systems and subsystems grouped according to function (which the author reports is similar to that employed in General Electric's $E^3$ project). Figures 4, references: 7 Russian.

UDC 519.958:533.7

**Calculation of the Non-Stationary Aerodynamic Characteristics of a Body During Detached Flow**
*18610310b Moscow VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 28 No 10, Oct 88 pp 1558-1566*

[Abstract of article by V.A. Aparinov, S.M. Belotserkovskiy, I.K. Lifanov and A.A. Mikhaylov, Moscow; submitted 19 Nov 87, resubmitted after corrections 2 Mar 88]

[Abstract] An approach is described for numerical modeling of three-dimensional detached flow around a nonstreamlined body, based on the discrete vortex method (closed vortex loops) developed earlier by Belotserkovskiy and Nisht. The body, having N proturberances from its otherwise smooth surface, is immersed in an ideal incompressible fluid; the detached flow occurs then at fixed locations near the body's surface. An integrodifferential mathematical model of the detached flow is constructed, and the basic principles of the discrete vortex method for converting it to a system of linear algebraic equations are adduced. Equations for calculating the aerodynamic loading are also formulated. The model was tested on a body in the shape of a cube and found to be in satisfactory agreement with experiment. This model will be useful in wind-loading studies of buildings and structures, in addition to streamlining of airplanes, ships, etc. Figures 4, references: 10 Russian.

UDC 517.958:533.7

**Calculation of Hypersonic Flow Around the Windward Side of a Low-Aspect Ratio Wing at High Attack Angles**
*18610310c Moscow VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 28, No 10, Oct 88 pp 1586-94*

[Abstract of article by V.N. Golubkin and V.V. Negoda, Moscow; submitted 9 Jul 87]

[Abstract] Hypersonic flow around a thin low-aspect ratio wing at an angle of attack near $\pi/2$ is studied. The shock layer consists of two regions: an external flow region which remains two-dimensional, and an internal one which is three-dimensional in character (for aspect ratios near unity, the entire flow has this three-dimensional nature). A system of nondegenerate equations is obtained by making some assumptions about the order of magnitude of the important gas-dynamic functions and expanding them into series, then substituting them into the Euler equations and Rankine-Hugoniot relations. These equations are then reduced to a solution which depends on the specific wing shape; for low-aspect ratios it is only valid far from the wall. Another solution

is required for the near-wall or "internal" region. This solution is obtained and connected to the "external" solution in the form of asymptotic functions. Finding the form of the shock wave front directly from this solution is mathematically quite difficult however, so the approach is a numerical solution of the inverse problem, which will allow us to show the physical sense behind this solution and to eventually solve the direct problem iteratively. Toward this end, a shock wave and leading edge is postulated and solved as a concrete example. The results show that the wing shape has a decisive influence on the hypersonic flow all around it, owing to the three-dimensional part of the two-layer flow. Figures 5, references: 12 Russian.

## Diamond-Like Material Obtained From Cubic Boron Nitride

*18610441 Moscow SOVETSKAYA BELORUSSIYA in Russian 5 Mar 89 p 2*

[Article by V. Bibikov]

[Excerpt] Associates of the Belorussian Academy of Sciences' Institute of Solid-State Physics and Semiconductors have obtained transparent specimens up to 11 millimeters in size which are practically equal to natural diamond in hardness and lustrousness. This relative of natural diamond was formed for the first time from cubic boron nitride instead of carbon. With the aid of processes and equipment which they developed, the Belorussian scientists obtained the transparent superhard material from a soft powder that is greasy to the touch. A high pressure and temperature are achieved in this equipment.

"The new material can have a wide range of uses, not only in cutting tools but also in jewelry and in components of optical equipment which operates in extreme conditions (the material withstands temperatures as high as 1,000 degrees Celsius)," explained Doctor of Technical Sciences, Professor A. M. Mazurenko, head of the institute's laboratory on synthesis of superhard materials and one of the authors of this development. "In addition to useful properties of natural diamond, the new material possesses a substantial piezoelectric effect, which opens up great possibilities for it in the radioelectronics industry and also in metalworking, for vibration cutting."

UDC 621.383.52:015.51

## Optimizing the Parameters of a High-Frequency Corrected Photoreceiver Circuit

*18610309 Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 31 No 10, Oct 88 pp 83-89*

[Abstract of article by I.D. Mitsenko and V.N. Legkiy, Novosibirsk Electical Engineering Institute; submitted 14 Oct 87]

[Abstract] Introducing the inertial action of an inductive element connected in series with the load in a photodetector circuit can correct the transient characteristics of the device over a wide range of frequencies, and thus make systematic-error corrections to the time of a pulse during additive interference of the useful signal with time-independent Gaussian noise. The goal is to find an optimal trade-off between gains in the accuracy of the device and increased power consumption, as reflected in the signal-to-noise ratio. An inductive equivalent circuit (an inductor in series with a load resistance, both in parallel with a capacitor, connected across the output voltage of the device) was analytically solved for aperiodic and resonance processes. After introducing a noise correlation function, an analytic expression for the signal-to-noise ration showed that the best conditions for signal separation and detection coincide during resonance oscillation processes in the inductive element, ensuring nearly optimal accuracy and sensitivity of the photodetector device. Figures 4, references: 2 Russian.

UDC 681.586.32+681.7.068

## Fiber Optics Device for Measuring Pressure Pulsations

*18610318f Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 88 pp 138-141*

[Abstract of article by I.S. Yavelov and Yu.A. Chernov, Machine Science Institute of the USSR Academy of Sciences, Moscow; submitted 16 Jun 87]

[Abstract] A fiber optics pressure transducer is constructed on the following priciple: light falls on a tiny transparent membrane and is transmitted to the irregularly-twisted ends of a lightpipe bundle; as the membrane flexes under the action of pressure fluctuations its reflectivity changes, modulating the amplitude of the measurement signal. For registering the pressure fluctuations in a typical weak shock wave (risetime of 8 to 10 $\mu$s), the thickness of the membrane (10Kh18N9t steel, HRC=24 to 27) varies from 0.044 to 0.118 mm and its diameter from 3.0 to 3.5 mm; nonlinearity errors appear to be less than 2.5% in this region. The measured natural frequencies of the transducer was between 95-110 kHz, and varied significantly from the calculated values due to sphericity of the membrane's inner surface; the natural frequency did not seem to depend much on the HRC index, although naturally a harder steel improves the elastic characteristics and increases the dynamic range of the device. Resonance oscillations and scatter of the signal front that could be up to 30 and 40% of the useful signal were significantly reduced by combined use of electrical filters and thermal insulating coatings. Experiments were also conducted to help select upper and lower frequencies for passbands of the secondary optoelectronic devices. The total error was found to be from about 10% for shock wave fronts to less than 3% for relatively low frequency pressure fluctuations. Figures 4, references: 6 Russian.

UDC 621.383.27

## Fast Photodetector with Automatic Sensitivity Regulation

*18610318g Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 88 pp 146-149*

[Abstract of article by N.V. Shiyanov, Moscow Aviation Institute; submitted 14 Sep 87]

[Abstract] The regulation characteristic curves were plotted from measurements of 10 samples each of four different types of photomultiplier cascade dynodes: scoop-shaped (as in the FEU-115), box-shaped (FEU-69), spherical (FEU-147) and jalousied (FEU-84). Based on this analysis, the FEU-115 was chosen for use in a fast photodetector device; its circuit diagram is adduced. The device is controlled by adjusting the FEU's anode sensitivity, and transient processes in the regulating system have been reduced to less than 1 ms by using a KT325B microwave transistor in the first stage to lower the dynamic capacitance. Experiments on the device have shown the possibility of further improvements yet in response time and dynamic range of the input signal. Figures 5, references: 4 Russian.

UDC 517.958:537.812

**An Inverse Problem in Coherent Optics. Using the Stationary Phase Method in the Problem of Focusing Radiation onto a Curve**

*18610310a Moscow VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 28 No 10, Oct 88 pp 1540-1550*

[Abstract of article by A.V. Goncharsky, M.V. Klibanov and V.V. Stepanov; submitted 18 June 87]

[Abstract] The intensity function of radiation focused onto a smoothly differentiable line is studied using the stationary phase method for the Fresnel integral of the field intensity in the focal plane. It is found that the intensity falls off sharply as one moves away from the focusing line; for characteristic parameters of optical elements, the width of the line of focus could be on the order of 10 to 100 μm. The concept of the intensity of the focused line (in the limit $k$ goes to infinity) is introduced, and its connection to the radiation intensity in the geometrical optics approximation is studied. The asymptotic intensity in the neighborhood of the ends of the line of focus is investigated. Drawing on "catastrophe" theory (the local structure of a function near one of its critical points) and Whitney's theorem, a theorem is proved showing that amplification of the intensity may take place at the ends of the curve for certain types of "joined" curves. Figures 2, references: 9 Russian.

## 3rd Unit of Southern Ukrainian AES Nears Completion

*18610125 Kiev RADYANSKA UKRAYINA in Ukrainian 5 Aug 88 p 2*

[Article by A. Nenko, member, Arbuzyn Rayon Committee of National Control; Yu. Oliynyk, chairman, Department of Technical Control, PU [expansion unknown], AES; A. Konoplyov, chief, No 2 Reactor Unit; and O. Haluza, H. Kuznetsov and V. Ratushnyy, workers]

[Text] The 3rd unit of the Southern Ukrainian AES is nearing startup this year. The unit is expected to become operational toward the end of December, leaving little time for the completion of challenging construction and engineering projects.

The construction and engineering personnel are aware of the approaching deadline for the startup of the 3rd unit, and are exerting maximum effort to bring the entire project to a successful conclusion.

The reserve transformers serving the 3rd unit have already been made operational in order to facilitate pre-startup procedures.

Workers responsible for installation and welding of the Kostyantyniv Construction Trust 'Teploenerhomontazh' have been the recipients of much praise for the efficiency they have exhibited in connection with the 3rd unit. The basic construction has been largely completed, with the final stages of assembly and hook-up into the energy grid now in progress. Much of the technical equipment and overload machinery has already been installed. The work teams headed by S. Ya. Sadovedov, I. I. Horodetskyy, Yu. I Pohorelov and H. V. Yurchuk, in particular, have turned in outstanding performances.

However, the installers and operators are faced with many difficulties that slow the tempo of their work. Many of the problems connected with construction and assembly became apparent last year. Both the planners and suppliers were to blame, as well as the construction teams that failed to master the fine points of the construction program. The result is a delay in the startup work. As a result, very few of the systems and units have undergone testing.

Work in the reactor sector is almost a month and a half behind. This is due to delayed construction and assembly in the electrical system of the project.

Welding work on the main turbine at the 3rd reactor unit requires a clean zone in order to insure high quality work and avoid any loss of time that would be the case otherwise. The welders are charged with joining 28 major elements, but the conditions for a successful completion of this job are lacking. In those areas where a clean zone is needed other work is still being completed by the workers of the Zuyiv section of the 'Donbasatomenerhomontazh' Trust and the No 4 industrial section of the Construction Administration. They are attempting to make up for a lax work schedule and, by the same token, are slowing others down.

The entire startup complex suffers from construction delays at group A water supply system and spraying equipment, construction of the pumping system, and chemical water treatment at the oil plant. At individual sites the delays amount to 50-60 days and require urgent corrective measures.

Slowdowns are also caused by constant misunderstandings with the planners. At the beginning of the year the Kharkov branch of the "Atomteploelektroproekt" Institute issued more than 260 instructions for technical changes and additional documentation. The solution of individual problems that arise during construction require up to 20 days for resolution, rather than the three days anticipated on the basis of standard construction practices. This situation is due to staff shortage and poorly qualified personnel.

The quality of work is especially important at nuclear plants. It is being monitored by the client, general contractor, and state technical control personnel. However, even here one encounters difficulties. The No 3 Construction Administration is in no hurry to repair the roof over the machine room and the aerator section. Problems have also come to light in the assembly of the turbines. Despite repeated requests by the department of technical control the general contractor of the AES Construction Administration is in no hurry to comply.

The State Commission has started its work on the 3rd unit at the Southern Ukrainian AES. The startup management group has already been at work for several months, and there are frequent visits to the work site from managers designated by the various ministries, associations, and trusts. Slowly, problems relating to construction, assembly, and supplies are being resolved.

The working conditions are also a topic of concern in the pre-startup phase, along with provisions for recreational facilities. The needs of the construction workers at the 3rd energy unit still remain to be met. Complaints are frequently heard about food service at the work site. Workers of the second and third shifts are left with nothing but leftovers.

The manner in which the workers are being kept informed about the state of affairs at the various projects also leaves something to be desired. Bulletin boards are unused, and the 'Komsomolskyy Prozhektor' stands empty. There is no information on the competition among some 40 work teams. These facts indicate that the unions and the Komsomol have given up before the startup.

In order to incorporate the Southern Ukrainian AES into the power grid on a timely basis there will have to be close cooperation among all those involved in its construction.

UDC 621.317

## High Intensity Vacuum Arc Frequency-Pulse Ion Amplifier

*18610318a Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 88 pp 28-31*

[Abstract of article by N.M. Arzubov, G.P. Isayev and A.I. Ryabchikov of the Nuclear Physics SRI at Tomsk Polytechnic University; submitted 30 Sep 87]

[Abstract] A frequency-pulse ion amplifier with capacitor-bank power supply was built and its operating characteristics investigated. The power supply system was very simple and required no synchronization of the voltages to the electrodes and accelerating gaps. Experiments were conducted using C, Al, Co, W, Fe, Cu, Ni and Ti as ion sources which indicated that the ion acceleration current and arc stability were influenced as much by the atomic mass of the cathode material as by its thermophysical characteristics. The total charge of ions reaching a collector at the output of the device was determined as a function of the pressure of the gas remaining in the evacuated acceleration chamber, and as a function of the pulse repetition frequency; from this it was determined that stable generation of a fairly pure ion beam is obtained at pressures less than $10^{-5}$ Torr and prf greater than 5 Hz. The characteristics of the ion beam as a function of the discharge parameters were also analyzed. Characteristic x-ray radiation showed that the resulting beam contains ions with charges of n=1 to 4. Either via electrode geometry or curvature of the fine tunsten screen forming the plasma emission bounday at the anode opening, the beam diameter can be varied between 0.2 and 20 cm. Beam current is 0.1—1 A, the accelerating voltage can be up to 50 kV, pulse length between 10 and $10^3$ μs, and prf up to $10^3$ Hz. This accelerator, with optimized geometry for controlling secondary electrons from the collector, would be particularly useful for delivering a uniformly-distributed current from the arc discharge to a thermally isolated cathode (i.e., under high-temperature conditions). Figures 3, references 8: 6 Russian, 2 Western.

621.384.64

**The "Uran" Linear Resonance Proton Accelerator for Applied Uses**
*18610318b Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian*
*No 5, Sep-Oct 88 pp 31-34*

[Abstract of article by O.A. Valdner, V.F. Gass, A.A. Glazkov, A.D. Kolyaskiy, A.I. Krivonosov, V.N. Leonov, N.R. Lobanov and O.S. Milovanov, Moscow Engineering Physics Institute; submitted 1 Sep 87]

[Abstract] The "Uran" linear proton accelerator is suitable for applied uses (i.e. in radiation materials science, microelectronics, pulsed chemical radiolysis, etc.) that require reliable and efficient acceleration of low-energy injected protons, and compact dimensions of the focusing elements through the use of asymmetric constant-phase focusing. A half-wave wiggler in the form of a degenerate spiral with two lengthwise electrodes is placed inside an evacuated drift tube that acts as the accelerating-focusing channel. The "Uran" accelerator consists of 3 such wigglers and 12 drift tubes operating at 150 MHz and 100 keV injection energy of the 80% proton beam (the remainder are deuterium, tritium and nitrogen ions) with an overall diameter of 284 mm and 600 mm length (including vacuum casing and supports). The system consists of an rf generator based on a five-stage lamp-type power amplifier; a proton injector; the accelerator proper; and a control system. A maximum pulsed proton current of 4 mA is obtained, although this does not appear to be the limiting value. The energy of the proton beam was determined by two methods to be around 1.1 MeV. Figures 4, tables 1, references: 5 Russian.

UDC 539.125.5.621.384.6

**The LNT-2M Neutron Accelerating Tube with Laser-Driven Ion Generation**
*18610318c Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian*
*No 5, Sep-Oct 88 pp 34-35*

[Abstract of article by V.A. Voytenko, V.M. Gulko, N.F. Kolomiyets and K.I. Yakovlev of the Nuclear Research Institute of the UkSSR Academy of Sciences in Kiev, and R.P. Pleshakova and A.Ye. Shikanov of the Nuclear Geophysics and Geochemistry SRI (A-U) in Moscow; submitted 24 Mar 87]

[Abstract] The LNT-2M neutron accelerating tube (250mm X 60mm o.d.) accepts pulsed-periodic laser light of 25 to 50 mJ and 15 ns pulse length, focusing it on plasma-forming targets within. Synchronously with the laser pulse, a electric field is applied between a radial cathode and anode, accelerating the deuterons in the plasma toward targets where 14 MeV neutrons are formed from the reaction $T(d,n)^4He$. *Studies of the service life of this device were done; it was found capable of producing neutron fluxes of 1 X $10^9$ $s^{-1}$ for several hours with an accelerating voltage of 130 kV and cycling frequency of 12.5 Hz, or as much as $10^{10}$ $s^{-1}$ for 150 kV and 100 Hz for shorter periods of time. Figures 3, references 5: 4 Russian, 1 Western.*

UDC 539.1.074.3

**Automatic System for Selection of Gamma-Telescope Events**
*18610318d Moscow PRIBORY ITEKHNIKAEKSPERIMENTA in Russian No 5, Sep-Oct 88 pp 45-50*

[Abstract of article by V.A. Grigoryev, I.V. Kalinin, V.A. Kaplin, Ye.G. Klyuchnik, V.A. Loginov, P.Yu. Naumov, and M.P. Sharapov, Moscow Engineering Physics Institute, submitted 23 Sep 87]

[Abstract] Microprocessor-controlled electronics for selecting useful events (i.e., rejecting spurious background events) in a spark-chamber-type gamma telescope have been developed, which will narrow its aperture to within about 10° of the device's axis while still maintaining a compact size and weight of the device, making it more practical for balloon-borne experiments. The device utilizes the positional sensitivity properties of the scintillation time-of-flight event selector (which triggers the spark chamber in the telescope) to determine the entrance angle

of a registered gamma-quantum. Block diagrams of the selection system and KR580IK80A microprocessor-based system are included, as well as a circuit diagram for measuring position and time-of-flight, and a-to-d conversion. The total time for processing an input trigger signal upon registering a particle is less than 400 ns. This system was tested on atmospheric muons, and showed an improvement by about an order of magnitude in the signal-to-noise ratio. Preliminary estimates have shown that for 100 MeV gamma quanta and a 10-fold aperture reduction, the registration efficiency of useful events is 70 to 75%, and increases with increasing gamma-quanta energy. Figures 5, references 5: 3 Russian, 2 Western.

UDC 539.104.42

## Proportional Counter for Mossbauer Investigations of Surface Layers at Temperatures of 100 to 700 K

*18610318e Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian*
*No 5, Sep-Oct 88 pp 56-58*

[Abstract of article by A.S. Kamzin and V.P. Rusakov, Physics and Engineering Insititute of the USSR Academy of Sciences, Leningrad; submitted 8 June 87]

[Abstract] A proportional counter has been developed that measured the Mossbauer spectra of $^{57}Fe$ by registering conversion electrons or characteristic x-ray radiation in the 100 to 700 K range. It meets the demands presented by this type of spectroscopy: no leakage of electricity from the isolator surface, the samples should be easily mounted inside the counter, the gas in the device should be inert and not decompose at high temperatures, all materials in the counter should be stable during heating and, most of all, should not give off gasses that might effect the counter's operation. The detector is contained in an aluminum housing 50 mm o.d. and about 15 mm long. In testing the device, it was found that a gas mixture of He+5% $CH_4$ was the best to use in electron conversion measurements above room temperature, He+5% CO was the best for lower than room temperatures, and Ar+4% $CH_4$ was suitable for registering characteristic x-ray radiation. The voltage to the counter when registering electron conversion and x-ray radiation was, respectively, 1000 and 1300 V at room temperatures; this fell by 100-150 V as the measurement temperature increased. An investigation of the magnetic structure of $Fe_3BO_6$ was conducted via Mossbauer spectroscopy of 150 $\overline{\text{ }}$-thick single crystal wafers of the substance enriched with $^{57}Fe$. The results match those found with traditional transmission-geometry setups and confirm the capabilities of this detector. Figures 3, references 10: 2 Russian, 8 Western.

UDC 621.165:621.438

**Steam/Gas Turbine Installations—A Cardinal Path for the Development of Power Engineering**
*18610172a Moscow TEPLOENERGETIKA in Russian No 11, Nov 88 pp 2-6*

[Abstract of article under the rubric "Perestroyka: Problems, Theory, Practice" by V.I. Gorin, A.F. Dyakov and G.G. Olkhovskiy of the Minenergo [USSR Ministry of Power Engineering] and VTI [Heat Engineering Institute imeni F. Dzershinskiy (A-U)]]

[Abstract] Gas turbines for power generation have gotten over their "growing pains" and are operating very reliably and economically at regional power stations in Yakutsk, Moldavia and Nevinnomyssk. The operating parameters of gas turbines of the present (GT-35, GT-100, GT-45) and future are tabulated. From this experience, we may formulate the technical requirements for the next generation of gas turbines: the GTE-150, GTE-115 and GTE-200 with initial temperatures of 1100 °C which, by dint of energetic efforts, could be put into widespread use during the 13th and 14th Five-Year Plans. Toward this end, manufacturing and testing work on the GTE-150 must be accelerated at the Turbine division of Leningrad Metals, and work on pilot designs of the GTE-115 must be accelerated as well at the Kharkov Turbine Plant. It is also proposed that a 12 to 50 MW GTE-series generator be developed for gas-pumping facilities and, eventually, use in power installations for developing regions. The technical requirements thus formulated include: reliability at least as high as in existing steam turbines, minimum servicing, ease of construction, ability to use a wide variety of fuels (including natural gas and gas made from coal), high efficiency, and low environmental impact, especially as regards exhaust of nitrous oxides. The advantages of combined-cycle power generation are set forth, and the parameters of foreign and Soviet schemes for this type of generation are tabulated and compared. Use of combined-cycle generation seems to be most practical in power plants that currently use natural gas. A 250 MW pilot combined-cycle steam/gas turbine is scheduled to come online during the 13th Five-Year Plan at the Kirov TETs-5. Savings from implementation of combined-cycle gas turbine installations could save 3 to 5 million tons of coal each year by the year 2000. Tables 3, references 5: 3 Russian, 2 Western.

UDC 621.165+621.438

**Boiler for 800-MW Steam/Gas Turbine**
*18610172b Moscow TEPLOENERGETIKA in Russian No 11, Nov 88 pp 10-16*

[Abstract of article by I.A. Sotnikov, Yu.A. Yershov and A.D. Chukanov, engineers at the Podolsk Machinery Plant imeni Ordzhonikidze; P.A. Berezinets, cand.tech.sci., VTI [All-Union Heating Institute imeni F. Dzerzhinskiy]; Ye.V. Shchukin, V.A. Solodovnikov and M.M. Shver, engineers with the VTI Special Design Bureau; A.N. Gulyayev, cand.tech.sci. KhF TsBK; and M.M. Levin, Ye.A. Cherepantsev and P.I. Volkovitskaya, engineers at the TsKTI [Central Scientific Research, Planning and Design Institute for Turbines and Boilers imeni I.I. Polzunov]

[Abstract] This 800-MW natural gas-fired steam/gas combined generation installation is the first of its kind to use the new second generation gas turbines with initial temperatures of 1030 to 1100 °C. In particular, the installation includes two GTE-150 gas turbines, two PP-77 boilers, and one K-450-12.7 steam turbine. The boilers are straight-through with intermediate superheating, producing up to 575 t/h of primary steam at 13.8 MPa and another 570 t/h of secondary steam at 3.5 MPa. Diagrams are presented showing five different design variants of the PP-77 boiler, as well as the steam circuits and natural gas circuits in the steam/gas turbine installation. A detailed comparison was made of the advantages and disadvantages of the various designs, resulting in the choice of the U-shape for the PP-77. Figures 6, tables 4, references: 3 Russian.

UDC 621.182.94-82:621.643.23

**Structural and Aerodynamic Characteristics of the Static and Psuedo-Liquified Layer of Thermal Power Plant Waste Ash**
*18610177a Moscow ELEKTRICHESKIYE STANTSII in Russian No 10, Oct 88 pp 18-22*

[Abstract of article by V.B. Sobachkin, engineer with the Siberian branch of VNIIG [Hydraulic Engineering SRI (A-U)] imeni B.Ye. Vedeneyev]

[Abstract] Experience from thermal power stations in Novo-Irkutsk, Barnaul and Novosibirsk, among others, has shown that unreliable emptying of ash catchers and clogging of the chutes transporting and collecting ash creates a near-emergency situation in practice. In part this is due to a lack of data on the characteristics of the ash produced in thermal power plants. To rectify this, SibVNIIG has undertaken an experimental study of the granulometric composition, density, structural state and aerodynamic characteristics of ash from the coal burned at different sites. A special apparatus was designed consisting of a glass cylinder 0.370 m tall and 0.107 m in diameter with a baffle plate in the bottom through which air was blown. The aerodynamic resistance of various depths of ash layers as a function of the air filtration speed was plotted, and it was found that the optimum was 12.5 to 18.2 mm/s for keeping the ash from packing down yet minimizing ash being carried away from the psuedo-liquified layer. The structural analysis has shown that for certain values of the residual structural-deformational hysteresis in the static volume, the formation of domes or areas of stagnant ash is likely in ash collectors and will have to be dealt with in their design. It was also found that the performance of aerogravitation devices with electric ash precipitators is improved by vibrating the sides of the flues at 4 to 6 Hz with an amplitude of 0.10 to 0.15 mm simultaneously with the blowthrough of constant or pulsed air streams. Figures 5, references: 5 Russian.

UDC 621.187.124

**Increasing the Throughput of Vacuum Deaerators**
*18610177b Moscow ELEKTRICHESKIYE STANTSII in Russian No 10, Oct 88 pp 32-35*

[Abstract of article by A.D. Kondratyev, Yu.P. Zaykov, Ye.P. Yeybog, N.F. Melentyev and A.A. Lepeshkina, engineers for Chelyabenergo]

[Abstract] In the late seventies, the need arose for a doubling of the throughput of the makeup water system at the Chelyabinsk GRES, meaning that each of the two DA-200 atmospheric deaerators would have to go from 200 to 400 t/h and provisions made for converting them to vacuum operation. A new design was proposed that would fit inside the old tower, and combine three types of deaeration: expansion of the superheated water in an evaporation chamber, by bubbling when steam is passed through the bypass water-seal, and by bubbling in bubbler plate. The improvements increased each unit's throughput to 850 t/h with no water hammer, and oxygen content well within norms. Another evaporation chamber could be added to further reduce the temperature of the heated medium. Figures 4, references: 7 Russian.

UDC 539.4.014:621.778.1.073:531.43

**Strength and Wear-Resistance of the Components of Hardmetal Drawing Dies**
*18610175d Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 88 p 119*

[Abstract of article No 4028-B88 deposited at VINITI on 25 May 88 by M.F. Glushko and V.M. Ocharenko; manuscript received 12 Feb 86]

[Abstract] Because of their hardness and brittleness, sintered carbide (hardmetal) drawing dies for dry drawing are often interference-fit into metal yokes or rings. On the basis of practical experience and strength/wear analyses, it is recommended the conical exterior surface of the drawing die be cold press-fit into the corresponding conical surface of the yoke, and the various parameters for this are determined (press-fit force, die dimensions, and the ratio of yoke yield point to the yield point of the part). This procedure should reduce breakage of the dies, increase product quality by evening out the compression along the contact surface with the extruding material, and decrease the mass of the dies by almost half.

UDC 621.8:539.3

**Investigation of Torsional Stresses in a Hollow X-Shaped Shaft**
*18610175c Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 88 p 118*

[Abstract of article No 3807-B88 deposited at VINITI on 18 May 88 by B.A. Obodovskiy, R.Ye. Urbanskiy and M.N. Gofman; manuscript submitted 24 Nov 86]

[Abstract] The stress-strain state of a shaft with an x-shaped cross section and central cylindrical cavity under torsion was determined. Starting from a complex functional form of the torsion, and an approximate conformal mapping from the exterior of a unit circle onto the exterior of the shaft cross-section, a set of equations was obtained that was incorporated into a computer model. The method was applied for various geometries of the outside surface of the shaft and diameters of the central cylindrical cavity. The resulting curves showed possible failure points in the various geometries. References: 3 Russian.

UDC 620.1.05

**Universal Run-Up Test Bed for Repeated Static Testing of Large Rotor Parts**
*18610175b Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 88 pp 114-116*

[Abstract of article by V.G. Bazhenov, Yu.I. Trostenyuk and V.K. Zakharov, Zhitomir branch of the Kiev Polytechnic Institute; submitted after revisions, 30 Jan 87]

[Abstract] The Engineering Mechanics Department of the the Kiev Polytechnical Institute, Zhitomir branch, has designed and built a run-up test bed 1500 mm high and 3500 mm in diameter for the new large rotors and rotor parts in modern motors and generators. The control system can be automatically adjusted during testing over a wide range of rotational velocities (8000 to 60,000 rpm), pressures, temperatures and temperature gradients (radial or axial) in the sealed testing chamber. A photograph and diagram of the installation is included, as well as a block diagram of the control system. Deformation in the most heavily-loaded areas of the tested rotors is measured with resistance strain gauges. The installation was used for full-scale testing of a gas-turbine engine fan housing during blade shearing. Figures 3, references: 11 Russian.

UDC 621.882

**The Strength Problem of Grouped Threaded Fasteners as Regards Nonuniformity in the Distribution of Tightening Forces on Each Bolt**
*18610175a Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 88 pp 108-114*

[Abstract of article by N.L. Klyachkin, Ulyanovsk Polytechnical Institute; submitted 10 Dec 86]

[Abstract] The basic principles are set forth for calculating the forces developed on a bolt during tightening; the design is for simplicity taken to be one with discrete joints of modest thread contact length below the level of the opening. A method is adduced for calculating the optimal force on each bolt at various stages of the overall tightening. On this basis, considerable attention is devoted to looking at the results of a more detailed method of determining the nonlinear relationship between the forces on the bolt being tightened and those transferred to the remaining bolts by flexure in a continuous connector design (band or flange-type). Coefficients characterizing the mutual influence of tightening as a function of the design's compliance are adduced, as determined from semi-empirical methods using a simple beam with bolts passing through it as a model. Figures 3, references: 15 Russian.

UDC 331.875.4:002.237

## Automating Control of Production Quality of Machine Building Complex

*18610317a Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9, Sep 88 pp 28-29*

[Article by V. I. Zaytsev, candidate of economic sciences]

[Text] The implementation of the strategic course of the CPSU for accelerating the country's socioeconomic development and increasing the efficiency of social production will, to a significant degree, depend upon the quality of the production of the machine building complex and on improving its technical and economic characteristics and competitiveness on the world market. The specified ultimate integrated quality indicators for machine building production are essentially formulated in the scientific research and experimental design stage. Automating work to control production quality should therefore provide for increasing the effectiveness of design based on an analysis and assessment of the quality of proposed versions in a sliding mode and selecting optimal design decisions.

Automated production quality control systems at the interbranch, branch, and territorial levels have already been created and are being successfully developed.

Each production quality control level corresponds to a specific automated system. At enterprises and associations an automated production quality control system is singled out in the structure of automated production management systems as a functional subsystem. The imperfections of the automated production management system's supporting subsystems, particularly the software unit in the mathematical modeling of production quality control processes, is a serious obstacle to their development and functioning. Constructing a mathematical model of the quality control process is a complicated task since it is difficult to encompass and tie together the enormous number of factors affecting the process. Accomplishing this task requires the appropriate mathematical apparatus, i.e., a system of algorithms and computer programs. The use of the latest mathematical methods at the enterprise and association management level, let alone the use of these models to study micromodels of production quality control, is still very insignificant.

The introduction of the automated system DESIT has opened up the fundamentally new possibility of accomplishing this task. In the Lvov Oblast, for example, the introduction of the DESIT automated system as a part of the territorial production quality control system during the 11th Five-Year-Plan made it possible to raise the relative proportion of consumer goods subject to certification that received the State Emblem of Quality to 40 percent by 1985. At some enterprises in the machine building complex (the Drogobych Automotive Plant imeni the 60th Anniversary of the October Revolution, the Konveyer Production Association, etc.), this indicator is between 85 and 100 percent.

The analysis, evaluation, and optimization of the level of production quality are implemented in several sequential stages. The first stage entails performing a set of interconnected tasks related to mathematically modeling production quality indicators by using existing theoretical and practical linear and nonlinear programming methods and systems of correlation coefficients and multiple correlation regression coefficients.

The comprehensive and integrated quality indicators thereby developed are then used in the second stage of the functioning of the DESIT automated system where the domain of admissible values of the production quality indicators from the standpoint of its producers and consumers is established.

In the third stage vector optimization problems based on a system of inequalities are solved to find the optimal values of the quality indicators under the conditions of an increase in the requirements for their technical and economic level.

The economic support and software provided in the DESIT automated system thus make it possible to solve a set of interconnected problems related to selecting indicators characterizing the quality of production (its technical level, technological feasibility, economy, competitiveness, etc.), link the production quality parameters with economic indicators of enterprises' and associations' production activity, and find optimal values of products' technical characteristics.

The automated system's hardware is designed for YeS computers using the algorithmic language FORTRAN. A number of operations may be performed in an interactive mode, for example, determining the domain of alternative values for the parameters of prototype machines and pieces of equipment. The level of operational management and control over the development of new types of technology is increased as a result. The efficiency and reliability of the DESIT automated system is increased significantly if it is based on new systemwide YeS computers and personal computers united into a single system. The introduction of special automated devices for inputting information into computers from machine documents is also promising.

In the 12th Five-Year-Plan, the hardware of the automated production quality control system is oriented toward the use of large computers at large enterprises in the machine building complex. Minicomputers are used more widely at scientific research institutes and design offices. At all other levels of production quality control, modern communications and office equipment is used in conjunction with microcomputers.

The DESIT automated system is designed to determine formalized production quality and is based on the use of a set of tightly interconnected economic and mathematical models for the purpose of obtaining multiversion optimum decisions. However, the final decision making and calculation of nonformalized quality indicators and parameters remains a competence of managers and engineering and technical personnel at planning and design organizations.

The use of economic and mathematical methods and optimal product quality control models in the DESIT automated system may serve as the foundation for developing software for automated production quality control systems at enterprises and associations with an allowance for the specific details of the production process and hardware complex supporting the system's functioning. In machine building, the formulation of a unified information base should be included as one of most important directions in designing an automated production quality control system. In our view, it should include several information files and should consist of the following five integrated blocks: standards and specifications; raw materials, materials, and intermediate products; the technical level and technology of production; personnel, wages, and incentives; and finances.

The information block dealing with standards and specifications contains data about unified requirements imposed upon machine building production quality, reliability and durability, its specified physicomechanical and chemical properties, and analytical quality indicators compared with the best prototypes in our country and abroad. This block also includes information about the most important technical, production, and operational product quality indicators that have been established in the state standardization system.

The information block dealing with raw materials, materials, and intermediate products includes data about technical characteristics, consumption norms, the presence of stockpiles and warehouse storage conditions, and the dynamics of fund realization.

The information block dealing with the technical level and technology of production contains statistical and analytical information about the principal indicators of the level of mechanization and automation of production, the introduction of new types of products (industrial series) and progressive production processes, the principal indicators of the technical and economic level of production and products manufactured, and indicators of the balance of production capacities and the balance of fixed production capital.

A separate block is intended for inputting information characterizing the level of workers' and employees' qualifications and the system for training and retraining personnel. It contains data about the ordering of forms and the labor wage system, the dynamics of rewarding workers and engineering and technical personnel for increasing the quality of products output and introducing progressive forms of brigade labor organization.

The information block dealing with finances includes synthetic and analytical accounting data on the results of the enterprise's economic and financial activity, including the amount, sources, and conditions of monetary resource formation and interrelations with the budget and credit system.

The system of integrated information blocks makes it possible, within the framework of the automated production quality control system, to create an automated data bank for accumulating, storing, retrieving, and outputting normative-reference and statistical and planning information. A package of product quality control tasks for formulating a fund of analogues from which optimal versions of the functional and information structures of the automated production quality control system can then be selected is stored in the automated data bank. In practical terms, this reduces document turnover and information streams at different planning levels and in different stages of a product's life cycle. Equipping designers', engineering and technical personnel's, and economists' workstations with personnel computers linked to systemwide computers in a computer center provides online access to the automatic data bank's files to permit the timely making of management decisions.

A network planning and management system is an important tool in automating work related to product quality control. Unfortunately, such a system is still not used in the automated production quality control system for the enterprises and associations of the machine building complex. The effectiveness of a network planning and management system within the framework of an automated production quality control system will, above all, be demonstrated by the fact that it permits the following:

—linking all stages of work related to creating and launching the production of new types of instruments, machines, and equipment (planning and design work, the material and technical preparation of production, the manufacture and testing of a product prototype, the transfer of documentation to production) into a unified network graph;

—demonstrating the interconnection of scientific research and experimental design work;

—finding the longest (the so-called critical) path determining the duration of the entire cycle of operations;

—determining (by using a computer) the degree of reliability of the slated time frames and the level of possible deviations of the network graph parameters (early beginnings and ends and late beginnings and ends of the work covered in the network graph) from the slated times;

—determining complete and partial time reserves that may be placed at the disposal of the development manager;

—including additional work in the network graph or consolidating existing work when necessary during the course of operations management and monitoring the fulfillment of the entire program;

—objectively assessing the course of the work being performed, discovering bottlenecks and irrational planning decisions, and taking quick measures to eliminate them.

The source data for calculating the time parameters of the network graph are stored in the automatic data bank's memory. The network data are periodically (two to three times per week) reassessed during the operations management and product quality control in view of deviations that arise during the course of the performance of the jobs specified on the network graph. It is suggested that the following six working files be formulated in the automated data bank for this: $T_{ij}$, a file on the duration of the performance of the jobs specified on the network graph; $E_{ij}$, a file on early beginnings and early endings of the jobs on the network graph; $L_{ij}$, a file on late beginnings and endings of the jobs specified on the network graph; $A_j$, a file of early and late arrivals of events specified on the network graph; $M^p_{ij}$, a file of complete time margins of the jobs; and $M^p_{ij}$, a file of partial (local) time margins of jobs.

The network graph parameters are calculated on the basis of existing economic and mathematical models. For example, the time of the critical path $T_{crit} = \max t^{eo}_{ij}$, where $T_{crit}$ is the time at which the development and production launch of a new product ends and $t^{eo}_{ij}$ is the time of the early end of the jobs $t_{ij}$.

The system of network planning within the framework of an automated production quality control system provides active monitoring of the course of planning developments of new types of machinery and equipment and their timely launch into production.

Only those jobs in which there are deviations from the initially slated time spans are brought to the planning manager's attention. This allows him to concentrate his attention on solving nodal problems and on taking quick measures to eliminate shortcomings in the implementation of the entire program of operations.

The practice of work at the enterprises and associations of the machine building complex under self-finance and cost recovery shows that the development and introduction of branch automated production quality control systems should be implemented in conjunction with a system of measures to make efficient use of the economic levers and stimuli for increasing production quality. These include a set of material and morale incentives to the labor collectives as a whole and to each specific worker for the manufacture of high-quality products that meet consumer requirements.



UDC Δ621.9.06.002:061.4

## Experience of Industrial Enterprises Regarding Certification and Rationalizing Workstations

*18610317b Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 9, Sep 88 pp 37-38*

[Article by Ye. T. Larina under the "Exhibition of USSR National Economic Achievements" rubric: "Experience of Industrial Enterprises Regarding Certification and Rationalization of Workstations]

[Text] In light of the 27th CPSU congress, the certification and rationalization of workstations is one of the most important directions in intensifying production and increasing the use of production and labor potential. The certification of workstations is a set of measures related to the complex assessment of each workstation to determine its conformity to the top scientific-technical and organizational level.

An exhibition devoted to this critical theme, which opened in January in the Standards Pavilion, acquainted visitors with the experience that has been accrued by the enterprises of the industrial sectors.

Certification and rationalization of workstations is directed toward making better use of internal production resources and solving socioeconomic problems. Its purpose is to determine the actual state of the organization of workstations and to establish the degree to which they conform to standard labor organization plans and modern technical norms and standards for using live and reified labor.

The fundamental innovation of certifying workstations lies in the fact that the; are evaluated in an integrated manner from the standpoint of technical-economic, organizational, and social factors and that this creates the possibility of developing and implementing different measures to increase production efficiency in a purposeful and interrelated manner on a unified methodological foundation.

The experience of machine tool building enterprises was particularly extensively demonstrated at the exhibition.

At the Ryazan Speical Production Association special attention is placed on a system of scheduled and preventive maintenance of workstations with instrumentation

and technical documentation and, in connection with this, on the presence of quality and timely planned shift assignments that are issued by an automated management system.

The instrumentation support subsystem is based on the data base of a control computer complex. The data base contains information about the selection, adjustment, and assembly/disassembly of tools. After processing the shift assignment jobs, the control computer complex outputs a schedule entitled "Shift Assignment Tool List." Introducing the management system has made it possible to reduce the preparatory and concluding time involved in machining components on NC machine tools and in automated sections by 35 percent.

As a result of certifying and rationalizing its workstations, the Red Proletariat Interbranch Special Production Association created a finished product manufacturing section to manufacture a "linear ball bearing guideway" assembly. By selecting equipment rationally, updating it, and creating high-productivity automated equipping, it became possible to introduce multiple-machine tool servicing (in which 5 workers service 10 units of production equipment), increase the machine shift coefficient from 1.2 to 1.8, and organize the brigade method of work with responsibility for product quality based on the end result.

Brigade workstations have been organized and are operational at the Vitebsk Red Labor Banner Tool-and-Cutter Grinding Machine Plant imeni the 22th CPSU Congress. This has made it possible to reduce the amount of office equipment and tools. Both standard office equipment (trays for blanks, mountings under a tray) and office equipment manufactured by the plant itself (tool cabinets, racks for punched tape, replaceable cams, etc.) are used. Three to five machine tools may be located in a brigade workstation.

The general assembly section presented at the exhibition by the Kharkov Machine Tool Building Production Association is a component of a shop to produce machine tools with increased precision. After the the certification conducted by the plant commission, the planning of workstations conforms to the modern requirements for the scientific organization of labor. Twenty-three persons combined into six brigades work in the general assembly section. The mixing of occupations and interchangeability of workers has become widespread in brigades; 99.3 percent of the section's products are accepted when first presented.

The Minsk Red Labor Banner Cutting-off and Broaching Machine Production Association imeni S. M. Kirov presented an interesting experience in which the head organization used a computer to develop a workstation accounting and certification system and introduce it at each subdivision. Using the system has made it possible to free certification commissions from labor-intensive calculations and the formulation of documents and has made it possible to have on-line information regarding workstation certification.

Using computers reduces the time required to process and obtain data about the status of workstations and the course of their certification to one-fourth the original time. Computers also generate such data as summary workstation accounting and certification records and analyses of certification results, which are then transferred to the plant certification commission and to the plant's technical and economic services.

The summary report includes a whole series of information, including the degree of labor mechanization at workstations. At the end of the year, the computer issues a plan for main workstation use indicators.

As the exhibition has shown, the Gomel SPO imeni S. M. Kirov has done a great deal of work regarding workstation certification and rationalization.

A total of 1,259 workstations were examined with regard to 1985-1986 certification results. The measures implemented significantly raised the level to which the plants were furnished with technical equipment. NC machine tools are concentrated in four sections, and their introduction has made it possible to introduce multiple-machine tool servicing.

The creation of integrated sections and the use of NC machine tools made it possible to introduce progressive labor organization methods, with 95 percent of all workers being organized into brigades. A base for creating flexible manufacturing systems is now being created. These systems make it possible to retool production to manufacture a new product in a very short period of time and with minimal expenditures of physical and labor resources.

The introduction of progressive attachments, mechanized pneumatic tools, and diagnostic and measuring and testing stands to check the assemblies of NC machine tools in assembly shops has made it possible to reduce the labor intensity of assembly operations by 30 percent in 1986.

The certification of workstations at the Tiraspol Casting Machinery Plant imeni S. M. Kirov of the Moldavian production association Precision Casting Machines was conducted under conditions of extensive glasnost. Information about the certification was reflected on stands in shops, in large editions, etc.

The 11th Five-Year-Plan saw a significant increase in the production of modern automated lines and complexes for special casting methods that make it possible to introduce low-waste technology into industry, produce high-precision castings, save tens of thousands of tons of metal, and mechanize the labor of foundry hands.

The following organizational and social characteristics of workstations were determined as a result of their certification and rationalization: their conformity to normative requirements and progressive experience; the qualitative level of the engineering and technology used in them; the production potential of section, shop, and plant; and the degree of labor mechanization at each workstation. Reliable information was obtained regarding the percentage of workers involved in heavy physical labor.

Complexes with magnetic clamps for assembly and welding were introduced on the basis of the certification results. Retoolable universal assembly attachments with magnetic clamps are being successfully used under conditions of multiproduct small-series and pilot production in blank processing for assembly and welding operations.

The economic impact from using retoolable universal assembly attachments in a boiler and welding shop amounts to 1,500 rubles annually. Eliminating workstations along brass plating and nickel plating lines and replacing them by modern ALG-305 and MLG87 lines raised production conditions and production quality, increased labor productivity 3- and 1.5-fold (respectively), reduced production costs, and freed 7 workers.

The certification and rationalization of workstations became an important factor in raising production efficiency at the Dnepropetrovsk Machine Tool Plant. Certifications have been conducted at the plant since 1983 to maintain high labor productivity increases, increase the capital-output ratio, and reduce production expenditures while simultaneously increasing product output and constantly updating the range of products produced.

Organizing finished product manufacturing sections intended to machine one type of components with extensive use of high-productivity equipment and NC machine tools has had a particularly significant economic impact on the plant. The creation of these sections made it possible to introduce many workstations and intershop and interoperation transport.

The certification results have been made the basis of an integrated program to reduce the percentage of manual labor subsequently implemented at the plant.

As the exhibition demonstrated, work is underway to certify and rationalize workstations at the Sverdlovsk Red Labor Banner Tool Plant imeni the 60th Anniversary of the USSR. The certification was conducted with regard to the workstations of industrial and production personnel. Shop equipment plans were refined, the numeration order of workstations was established, an inventory was conducted, workers' certification commissions were created in shops, etc.

A total of 1,060 proposals wee accepted for further rationalizing workstations. The main proposals called for restoring and updating equipment at 108 workstations, introducing ways of mechanizing labor at 58 workstations, improving the use of each workstation, improving the load at each workstation, and increasing the shift coefficient at 157 workstations.

Mechanized and automated continuous production lines and integrated mechanized sections are successfully operating at the Kalinin Welded Structure Plant Tsentrosvar, and robots and retoolable flexible manufacturing systems have been introduced. The plotting boards and diagrams presented at the exhibition describe all of this.

The plant is paying particular attention to increasing the technical level of workstations by mechanization and automation based on the periodic integrated certification of workstations.

The accessory and cutting tool set exhibited by the All-Union Tool Scientific Research Institute is standard and is used in various sectors of the national economy. The cutting tool and attachment set is recommended for installation at wide-range specialists' and lathe hands' workstations. Using different attachments expands the production capabilities of equipment, makes it possible to eliminate manual labor, makes lathe hands' work easier, and increases labor productivity. The economic impact comes from increasing lathe hands' labor productivity by no less than 50 percent (under conditions of small-series and single-unit production).

At the Dnepropetrovsk Heavy Press Production Association it was decided to proceed down the road of expanding multiple-machine tool servicing during certification. Three directions were selected for this: grouping universal equipment used to machine components with a long machining cycle at workstations, creating workstations at which automatically operating equipment is installed, and grouping NC equipment at workstations. The creation of such workstations made it possible for a machine operator to service several units of equipment since the machine time when these components are machined significantly exceeds the auxiliary time.

Workers from the Kuznetsk Metallurgical Combine shared their interesting experience at the exhibition. They are continually working to increase the organizational level of their workstations. They have taken measures to develop the brigade form of labor organization, combine occupations, and improve labor norming. There are 1,048 brigades working at the combine, 668 of which are integrated brigades and 244 of which work under full cost-accounting. The work that has been done with regard to certifying and rationalizing workstations at the combine has further improved and increased the efficiency of metallurgical production.

The Shostka production association Svema has created a system to manage the workstation certification process. Specific tasks have been specified for the functional management services. The result has been an improvement in engineering and technology, the organization of labor and production, and better labor conditions; 1,435 workstations have been brought up to a level conforming to progressive decisions, and 60 are standard workstations. The standard level of workstation organization is primarily achieved by modernizing production processes and introducing robotized complexes.

A subsystem for certifying the level of labor norming at branch enterprises (NORMASTAT) was presented to visitors. It is a set of algorithms and software for solving the problems entailed in analyzing the status of and improving labor norming.

An automated subsystem for certifying the level of brigade forms of labor organization and keeping accounts of workstation certification and rationalization (ASBRIC) makes it possible to study the process in greater depth and to continually monitor and improve the brigade forms of labor organization being studied at any facility, including at the branch, subbranch, enterprise, production process, shop, and section level.

The system for the computer-aided design of equipment repair norm process charts (VIDEO-NTKI) is a systems problem-oriented set of data base management and organization, software, and hardware for interactively performing the tasks entailed in labor norming. The system is in operation at the Ministry of Mineral Fertilizer Production. It includes a video terminal-equipped automated workstation for a designer of repair norm process charts.

The process of certifying and rationalizing workstations is automated by using the ASU ARM [automated workstation automated management system] applications package, which belongs to the group of functional software. The ASU ARM applications package is intended to inventory and certify workstations and to produce (in an interactive mode) documents associated with the process of making managerial decisions.

Enterprise dispatchers' workstations were shown at the exhibition. These included the ARM Raskroy, an automated pattern cutter-technologist's workstation to automate the calculations entailed in spacing and cutting rolled metal stock in interactive and automated modes (the pattern cutter-technologist's labor productivity is increased 1.5- to 3-fold for a yearly economic impact of 20,000 to 100,000 rubles), and a set of workstations for shop managers and specialists (for the shop foreman, technical inspection department worker, technologist, standardizer, and state acceptance group). In its different sections, the exhibition acquainted visitors with the problems of increasing the organizational level of workstations, improving labor conditions and safety engineering, certifying sections and shops, and certifying workstations in construction and agriculture. Most of the attention was focused on the integrated solution of the social problems of labor at enterprises and in regions.

The experience of enterprises from different branches of industry regarding certifying and rationalizing workstations that was presented at the exhibition demonstrated that work in this direction is proceeding successfully.



UDC 629.113:621.83.061-52

## On the Development of Automatic Transmission Control Systems for Domestic Self-Propelled Machines

*18610075a Moscow VESTNIK MASHINOSTROYENIYA in Russian No 9, Sep 88 pp 9-11*

[Abstract of article by S.M. Belov, cand.tech.sci., and S.D. Galyuzhin, cand.tech.sci.]

[Abstract] Despite the underlying similarities, most control systems for the transmissions of self-propelled machines have been designed on a case-by-case basis. This is true in particular of diesel locomotives, whose transmission control systems are largely unmodified since they were designed 15 to 20 years ago. The TGM1 locomotive, and its offspring the TGM21, TGM23, TGM23B and TGM23V, use hydromechanical single-impulse systems (i.e., there is only one source of control variable information; two-impulse systems would use the locomotive velocity as the primary source, and motor shaft speed or throttle position as a secondary source). One exception is the TGM1 locomotives produced in 1958-1959 which used the Voith (Austria) L-26st transmission with two-impulse control system. Similar use of automatic transmissions is found in the Zil-4104 and GAZ-14 autos, and LiAZ-677 and LAZ-4202 buses. Comparing the UGP 350-500 transmission of a TGM23 and the Lviv-3 transmission in an LAZ-4202, we note that the shift points are quite similar—enough so that unification of control systems would make sense. Parameters for an automatic transmission in the D-240 engine in the MTZ-80A tractor are also graphically analyzed in some detail, and a simple functional diagram of a microprocessor-based two-impulse control system for it is adduced. Figures 4, references: 7 Russian.

UDC 658.512.011.56:621.655.9

## A Strategy for Optimal Design of Displacement Pump Automatic Regulators

*18610075b Moscow VESTNIK MASHINOSTROYENIYA in Russian No 9, Sep 88 pp 15-17*

[Abstract of article by D.N. Popov, doctor of technical sciences, and V.L. Khvan, engineer]

[Abstract] Various methods and means are discussed for determining an analytical design of the optimal regulator for a dynamic system through non-linear programming

and multicriterial analysis. An algorithm is oulined using some of these methods for practical optimization of the automatic regulator of an axial-cylinder displacement pump. The algorithm was employed in a computer model (using FORTRAN IV), and the response of the system to transient processes at various stages of the optimization were plotted. Block diagrams of a control system (based on electrohydraulic amplifiers, and analog electronic devices and transducers) are given; the primary control information is the position of the camshaft, its angular acceleration, the pressure in the hydraulic cylinders and the pressure in the output mains. The calculated results differ by no more than 7 percent from the results of bench tests of this system. Figures 3, references: 6 Russian.

UDC 629.12.001.24:681.32

## Elements of Interactive General Design Subsystem of Ship CAD System

*18610330a Leningrad SUDOSTROYENIYE in Russian No 1, Jan 89 pp 8-11*

[Article by D. N. Vasilyev, I. S. Konovchenko, Yu. V. Leonov, V. A. Razborov, and Ye. A. Kustov]

[Text] The computer-aided design systems (ship CAD system) now existing in the Soviet shipbuilding industry are oriented primarily toward the use of YeS computers; their modules function in the batch mode. Replacing the punch card as the main data storage device by its image on the screen on an alphanumeric display (AND) does not change the essence of the batch nature of the work. Data preparation and input in these systems are complicated, weakly automated, and do not permit the designer to alter data online, especially when working with graphics objects.

The great disadvantage of these systems, specifically of FORAN, is orientation toward foreign peripheral equipment (Benson and Koenigsberg plotters and Afigraf graphics display) and the essentially total disregard of serially manufactured Soviet complexes of the automated workstation type, specially designed to solve design problems. The results of initiative development of the elements of the first stage (mockup model) of the interactive subsystem "General design" of ship CAD systems (the abbreviation PIRS is an interactive ship development subsystem), executed for the Soviet ARM-M complex based on SM computers, are presented below.

The main difference of the proposed subsystem from existing systems is its interactive nature, provided through a branched multilevel "menu" system and extensive use of peripheral graphics data input and display devices. This permitted significant simplification and reduction of the time for input-output of graphics data and online conversion of it. An essential circumstance is that the user works only with customary shipbuilding concepts, without "programmed" procedures and terms.

The subsystem is a set of problem and service program packages, which function in the interactive mode and which accomplish information interaction through a local database (LDB). The overall structure of the subsystem is presented in the diagram.

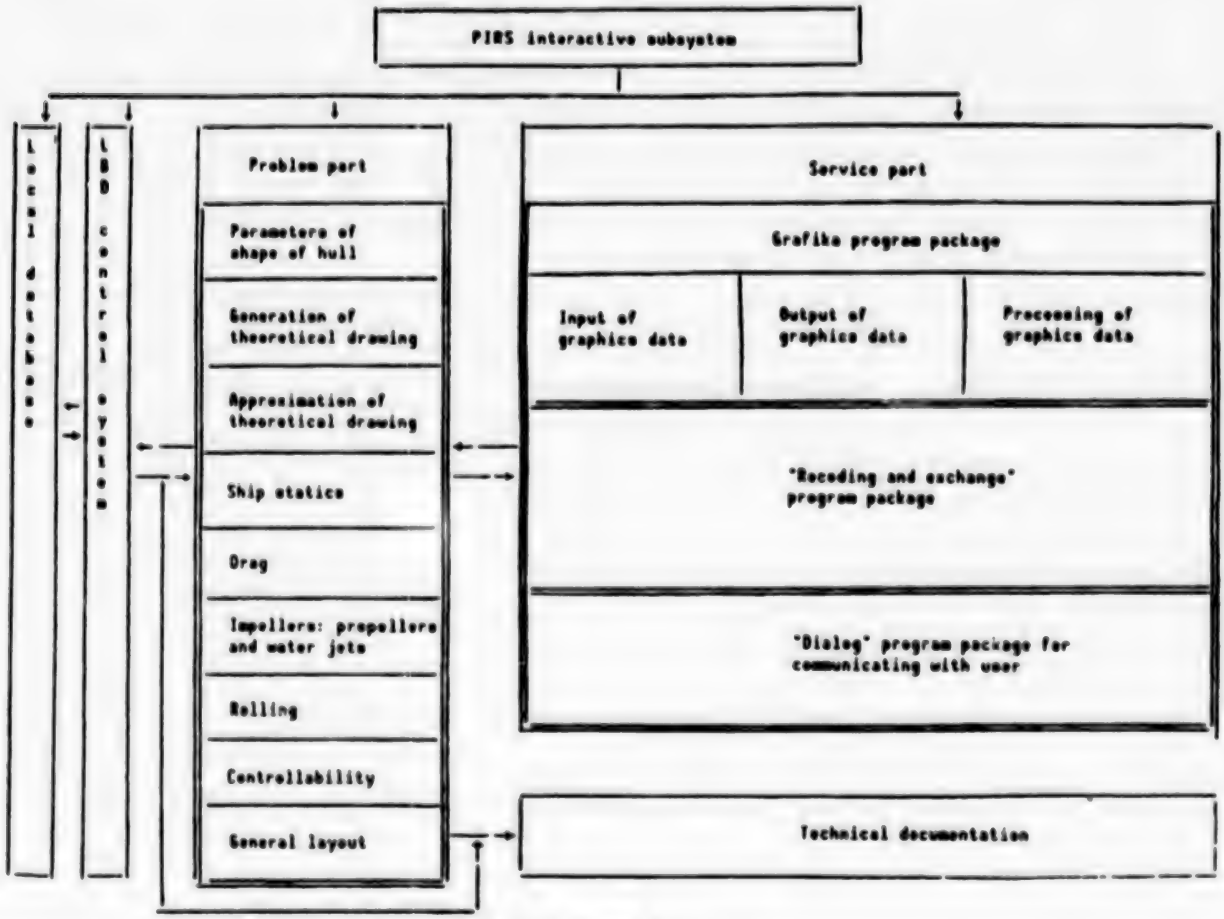
The problem part of the given variant of the system is designed for solution of purely shipbuilding problems. It is assumed that such optimization problems as determination of the economic impact, displacement, and main dimensions are executed in the automatic mode at the earliest stage of ship design. Let us consider briefly the problem packages that comprise the subsystem.

The program package "Shape parameters" of the ship hull is designed to select in the first approximation the parameters which characterize the dimensions and shape of both individual lines and of the surface of the hull as a whole when it is worked out by the "Generation of lines drawing plan" package (the length of the cylindrical insert, and coefficients, angle of entrance of the KVL [design waterline], midship section coefficient and so on). (Footnote 1) (TCh—lines drawing plan) Operating methods,[1] based on statistical data for various types of ships, are the basis. The numerical values of the parameters of shape proposed by the package are derived in tabular form to the AND screen. The user can correct any of the parameters by selecting its numerical value from the keyboard in formatless form.

The program package "Generation of lines drawing plan" is based on the frame-kinematic method of representing the surface and is designed to obtain both individual typical lines and the lines drawing plan as a whole from given measurements and parameters of the shape of the hull. The ship is divided into ends and the cylindrical insert. Each end is divided into surface and underwater parts and can be split by break lines into individual sections. The lines on which the contour of the frame section rests are the shell lines. The set of parameters, variation of which along the length of the ship is parametric lines, control the shape of the frame section. The specific combination of framework and parametric lines determines the surface of the ship.

The program package permits one to design lines of different configuration: transom, bulb, tunnel, ladle-like, and cruiser (with and without breaks). One of the characteristic features is the capability, if the customer desires, to change rather quickly the class of basic functions, with program organization and operating technology of the user unchanged. This permits a program package for working with a specific class of ship surfaces or for working with regard to the characteristic features of ship shapes not envisioned in the mathematical model.

The technique of working with the package is simple and convenient. The main dimensions and parameters of the shape are brought to the display screen through the local database from the package "Parameters of shape." After correction (if it is required), control is automatically transferred to the graphics display (GD), which is used to work out sequentially the framework lines (centerline, bow and buttocks lines, design waterline, deck line, line through the frame, and break line) and the projection "Hull." The parameters of the frames are then smoothed along the length of the ship (obtaining the parametric lines). The operating modes and parameters are varied with a "light pen," screen scales of the parameters of the curve and the "highlight menu" of the graphics display. By moving the light marker along the scale, the designer alters the parameters of shape online and produces a new shape of the curve.




Functional Diagram of PIRS Subsystem

Since the effect of the parameter on the projected line is easily visible on the display screen, the subsystem is at the same time actually a training subsystem with respect to the user. The self-teaching time of the user is dependent on his skills as a designer and comprises from one to three 2-hour work sessions. The traditional technique of working out the lines drawing plan from the line along the frames, customary to the designer, is fully retained in the subsystem. With this approach, the designer is able to obtain rapidly different versions of both individual curves and of entire projections of the lines drawing plan on the graphics display. The time of working out the entire lines with viewing of a large number of versions is usually within several days, depending on the type of lines drawing plan.

The final result of operation of the package is a set of parameters of framework and parametric lines drawing plan, entering the local database, the lines drawing plan drawn on the plotter according to the YeSDK [Unified System of Design Documentation], and table of mold offsets. An example of the lines drawing plan, developed by the package "Generation of lines," is presented in Figure 1.

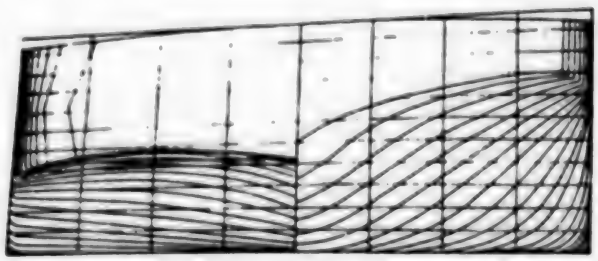


Figure 1. Projections "Hull" of Lines Drawing Plan of Tugboat With Tunnel Lines

The program package "Approximation of lines drawing plan" is designed to formulate the mathematical model of the ship surface with regard to the technology of manufacturing it on the basis of the initial lines drawing plan; it is also based on the framework kinematic method. The designer superimposes the longitudinal framework lines that divide the surface into sections, typical in the technological sense (lines of sharp variation of curvature, breaks, and plane sections of surface) additionally on the initial lines. Supplementary frames

"break through" at the break points and "jumps" of the framework lines (transom, step, abutment bilge and lines of plane sections of the bottom).

Surface sections can be plane, liner and of double curvature. Longitudinal framework lines may fuse, may be break lines and may be lines of disappearing break. Sections of framework and parametric lines and also sections of the frames between framework lines are described by parametric functions, dependent on the moving coordinate and on a number of parameters. The sequence of approximation of the lines is mainly such in the given case as in the program package "Generation of lines." The distinguishing feature is the presence of "point" given lines and organization of their entry into the computer.

The data on lines is divided into semantic and graphics information. Semantic information (main dimensions, number of framework lines and a number of other data) is entered from the alphanumeric display. If the semantic information were entered earlier, it goes to the local database. The graphics information (longitudinal framework lines and frame lines) are entered from the graphics information coder (PKGIO) by the point "shearing" or "outline" method; the accuracy of the PKGIO is 0.3 mm.

Simultaneously with input, the information is displayed on the graphics display and is checked visually. A committed error during "shearing" or soft failure of the PKGIO is corrected immediately by pressing the corresponding PKGIO function key. Input of graphics information occupies from 30 to 60 min and is dependent on the complexity of the ship lines.

The framework lines, frame lines, and parametric lines are approximated both in the automatic and in the interactive correcting mode by varying the parameters of the lines until the necessary accuracy is achieved. The parameters are corrected with the "light pen" on the screen scale principle on the graphics display with online display of the result.

The result of the work is a mathematical model of the ship surface in the local database, lines drawn on the plotter, and table of mold offsets. The time of interactive approximation of the lines comprises from 1 to 3 days as a function of the complexity of the lines, including the time of initial lines preparation. The drawing "hull," obtained by the package "Approximation of line," is presented in Figure 2.

The program package "Statics" contains all the calculations required by the sector standard and consists of the following modules: calculation of the curves of the buoyancy elements and Bonjean diagram, calculation of the fit, calculation of the elements of the initial stability and of diagrams of stability with different ship load versions, calculations of unsinkability (fit and diagrams

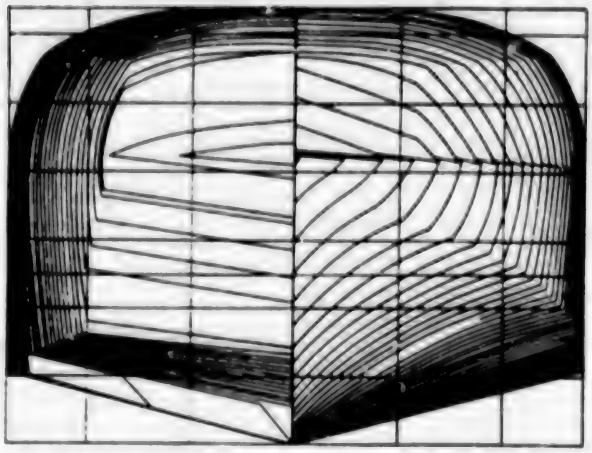


Figure 2. Projection of Ship "Hull" on Hydrofoils

of stability with different versions of loading and flooding of compartments). The algorithms of [2], modified in solution of the ship fit control system, were used in working out the programs.

The input data for the hull configuration comes from the local database. The location of the assigned frames is indicated from the alphanumeric display. If a mathematical description of the lines drawing plan is absent in the local database, one can use the specialized interactive input module of the lines drawing plan of flooded compartments from the PKGIO. The supplementary information required for specific calculation comes from the local database, and if the information is absent in the local database, one automatically requests from the alphanumeric display as necessary.

The geometric information coming from the local database or from the PKGIO during "pin-hole copying" is checked due to its display on the graphics display; the possibility of online correction of the input data is provided. Graphics information in the Bonjean diagram, of the curves of buoyancy elements, and of the diagram of stability is output at the user's requirement to the graphics display screen or to a plotter. A three-dimensional pattern of the position of the ship with respect to the existing waterline with truncated underwater part of the hull is also output to the screen during calculations of the fit and of the diagram of stability.

The results of calculations, formulated according to sector and State Standards, are delivered to the alphanumeric printer and to the plotter. Online output is provided to the alphanumeric and graphics display screens.

The program package "Drag" is designed to calculate the drag of the water to the motion of the displacing ship. The calculation is based on empirical methods, worked out from the results of systematic tests of ship models.

The results of [3] are used as input data. Preliminary statistical processing was carried out and analytical functions were found for methods based only on graphic representation of the input functions. The results of calculation are delivered in the form of printed documents and of a draft curve on the plotter and graphics display.

The program package "Impeller" consists of two main interactive modules: "Screws and water jets." Both modules are designed to select the optimal geometric parameters of the screw or of a multistage water jet system for different operating modes of the impeller: minimization of the required power at given displacement and speed of the ship, provision of maximum speed (at given displacement and power plant) and of displacement (at given speed and power plant), maximization of thrust at the "crest" of drag (for a water jet) at given speed and displacement of the ship. The module "Water jet" is oriented mainly toward use in design of high-speed ships.

Calculation of the hydrodynamic and energy characteristics of the screw or water jet in any of the modes is based on the use of the diagram of serial tests of the models of the screws and rotors of multistage water jet propellers; the diagrams are stored in the local database. The type of diagram to be used for the designed screw or stage of the water jet pump is assigned by the user in the interactive mode.

The coefficients of interaction of the propeller and hull can be calculated in three versions: by the fixed values assigned by the designer in the calculating mode, by known empirical relations and by the results of self-propelled model tests. The variants are selected by the user. The hydrodynamic characteristics of the given type of water intake, of the inner channel to the system rotor, and also the characteristics of the propellers to be used are stored in the local database for calculation of the water jet system. The graphics information (diagrams and graphs) are entered in the local database once with the PKGIO by a special interactive module.

A visual check of the intermediate results is possible on an alphanumeric display during optimization of the parameters.

The program package "Rolling" is designed to calculate the parameters of rolling in irregular seas. It consists of modules that permit one to calculate the rolling motion of the ship, the transverse horizontal and vertical vibrations of the ship, arranged by the log to the wave, and longitudinal rolling of the ship, arranged contrary to the wave. The input nomograms were first converted to graphs of the functions of several variables. The input graphics data on the characteristics of seas, converted by the nomograms and graphs for calculation of the rolling resistance and reduced masses during calculation, is entered from the PKGIO coder, is approximated, and the coefficients of approximation are fed to the local database. The approximation is made by a special module according to the least squares method for functions of one to two variables.

Input data on the characteristics of the ship usually come from the local database, while data on the characteristics of seas, the class of ship and the method of calculation are delivered as a result of interaction with the alphanumeric display. The user can change the parameters of calculation at any time. The results are printed out in tabular form.

The program packages "Controllability" and "General position" are in the stage of development. The package "General layout" is based on the semiautomatic principle of arrangement of conditional geometric figures, corresponding to individual assemblies of the ship, with active use of the graphics display and of the PKGIO graphics data coder.

The service part of the subsystem consists of program packages that support functioning of the graphics peripherals together with the problems part, local database and standard operating system of SM computers. The need to develop the service part was caused by the fact that the standard versions of software for working with graphics devices, which existed up to the beginning of development of the PIRS subsystem, did not meet the necessary requirements for an online dialogue. Access to the graphics devices of the ARM-M package directly from the program in a Fortran-type language was impossible. Transfer between devices was achieved only from the alphanumeric display in the command language of the operating system. The graphics software now delivered, although it is devoid of this defect, is oriented only toward the plotter and the Grafit graphics display, and also occupies such a main memory capacity that it is essentially impossible to arrange the problem modules in it.

The developed service part of the PIRS subsystem is devoid of the indicated deficiencies. It permits one to work online with all graphics devices of the ARM-M package and occupies a small main memory capacity. The graphics service part includes program modules of three types: a program driver in Assembler SM language, modules included in the operating system and which provide an interface for interaction of the operating system monitor to peripherals, and programs for data conversion coming from applications packages to the format of a specific graphics device, interacting through the operating system monitor with the drivers, and programs in Fortran language that provide "fragmentation," "scaling" and formulation of standard graphics elements.

The program package for working with the graphics information input device PKGIO provides semiautomatic entry of point coordinates, lines with indication of their type (solid, thick, thin, dashed and so on), circles,

arcs from a drawing on a plotting board, and also symbols and service codes from the symbol field of the plotting board or keyboard directly into the main memory of the computer.

The program package for working with the plotter delivers information in the form of lines of arbitrary type, assigned by the coordinates of its separate points, connected by straight line segments, geometric figures (rectangle, polygon, circle, ellipse, and grid) of standard graphics formulation of the drawing, and alphanumeric legends of the required size. The drawing can be delivered by one of three writing tools in the required scale.

The program package for working with the graphics display Grafit works with graphics and symbolic information both in the input mode from the graphics display screen and in the output mode to the screen. The type of information during input-output is the same as when working with the PKGIO and graph plotter.

The local database is designed on the simplest "direct access" principle to any information. The local database has a catalog of the names of data for the ship, used by the PIRS subsystem, which can be easily supplemented and edited by special interactive modules.

All the problem modules use elements of the catalog of names to ensure a standard tabular format of data input-output. The simplicity of storage and access to data permitted creation of local databases, small in the volume of the control program, and permits one to work out a communication interface with a global database within rather short deadlines.

Service modules are being worked out to transfer data from the PRIS subsystem to the ATOPS system, more widespread in the sector.

**Bibliography**

1. Karpov, A. B., "Parameters for Determining the Main Dimensions and Block Coefficients of Inland and Mixed Navigation Ships," SUDOSTROYENIYE, No 3, 1977.

2. Bregman, V. I., "Resheniye zadach statiki korablya na EVM" [Computer Solution of Problems of Ship Statics], Leningrad, Izdatelstvo "Sudostroyeniye," 1966.

3. Khorenko, V. I., "Avtomatizatsiya raschetov khodkosti na osnovye matematicheskikh modeley" [Automation of Calculations of Marketability Based on Mathematical Models], Leningrad, Izdatelstvo "Sudostroyeniye," 1977.



UDC [001.89.003:658.011.56]:629.12

## Analysis of Objects and Processes of Design in Development of CAD Systems for Ship Machine-Building Products

*18610330b Leningrad SUDOSTROYENIYE in Russian No 1, Jan 89 pp 30-33*

[Article by M. M. Georgiyevskiy]

[Text] The need for a significant increase of labor productivity in development of new technology resulted in development of applied research in the sector, oriented toward development of computer-aided design systems (SAPR). The characteristic feature of ship machine building is the wide nomenclature of various types of manufactured products with respect to low integration of their design. Moreover, the traditional specialization of enterprises determines the existing differences in their scientific and technical potential, their being equipped with computer technology, and experience in operating it. The noted aspects, along with rigid deadlines for development of a CAD system, force the enterprises of the subsector to seek their own paths in development of computer-aided systems which, on the one hand, leads to results of different value with significant material expenditures, and on the other hand, limits the possibility of cooperation in development of CAD system components, the use of finished developments of other enterprises or at least of their positive experience.

The problem of standardizing the approach to development of CAD systems, i.e., development of methodical bases, universal models, invariant design and servicing subsystems of CAD systems that permit one to make the process of working them out more deterministic, and increasing the economic impact due to introduction, is timely in this regard. This approach is primarily feasible for traditional ship machine-building products—elements of the main and auxiliary power plants, power supply systems, power drives and deck mechanisms having the standing design methodology, high level of standardization and unitization and assembly units and parts.

Development of a CAD system begins with study of the objects and processes of design for formalization of them. Let us consider this aspect, since the results of these studies determine to a considerable degree the labor intensiveness of further work and the efficiency of using the CAD systems.

CAD systems are essentially expressions of the systems approach to design, which, on the one hand, is manifested in classification of mathematical models and design methodology, and on the other hand, in development of the organizational structure and software and hardware system. The systems analysis method is selected as the working apparatus of the study[1,2]. The starting point is how to organize the design process for

the current moment of development of science and technology, which mathematical models, data, methods and means should be used to obtain the optimal design by the optimal method. The extent of development of the design system should be estimated by the technical and economic feasibility, i.e., by the discernible advantage in improving the technical indicators of the product and of reducing the cost of developing it compared to additional expenditures for research and development, and acquisition and development of hardware for the CAD system.

The object is considered from the aspect of the systems approach as a complex system, consisting of a set of interconnected elements, the combination of which determines the specific elements, inherent only to a given object of quality. Moreover, the optimal sequence of actions of the designer, directed toward development of the design, should be determined in a specific sense during systems analysis of the product. (The design is meant as the traditional set of designer documents or a system of digital models of the product and of its elements, formulated on magnetic storage devices, which has the status of the design under conditions of integrated automation of the "design-preparation of production-manufacture" process). Analysis of the object begins with dividing its elements by hierarchical levels and determining the characteristic features (or attributes) of the elements of each level. The combination of attributes should fully determine the considered element. A diagram of dividing the product into levels is presented in Figure 1 and their attributes are enumerated. The product as a whole is considered at the highest level, its main functional modules (assembly units) are then considered, and the assembly units contained in the functional modules and which make up their assembly units are then considered. Parts are related to the lowest level. The number of levels is determined by the degree of complexity of the object

Let us dwell in more detail on analysis of the highest level, i.e., of the product as a whole. The originality of the product is determined by the area of application, by the purpose of design, by the functions to be performed, and by design realization. The enumerated characteristics are reflected in the following attributes: by the technical assignment for design (TZ), by the standardized solution of the product (standard size series) of the mathematical model, specification of functional modules, schematic solutions, and criteria of quality.

When considering the technical assignment, the data included in it can be divided into the following groups: data that reflect the operating conditions according to the main designation—the rated and limiting values of power, kinematic, electrical, and thermal parameters of the product, its energy indicators, power sources and their parameters, the conditions for integration with other products and systems, the conditions of arrangement on the ship, environmental conditions, the characteristics of the general technical level—reliability, service

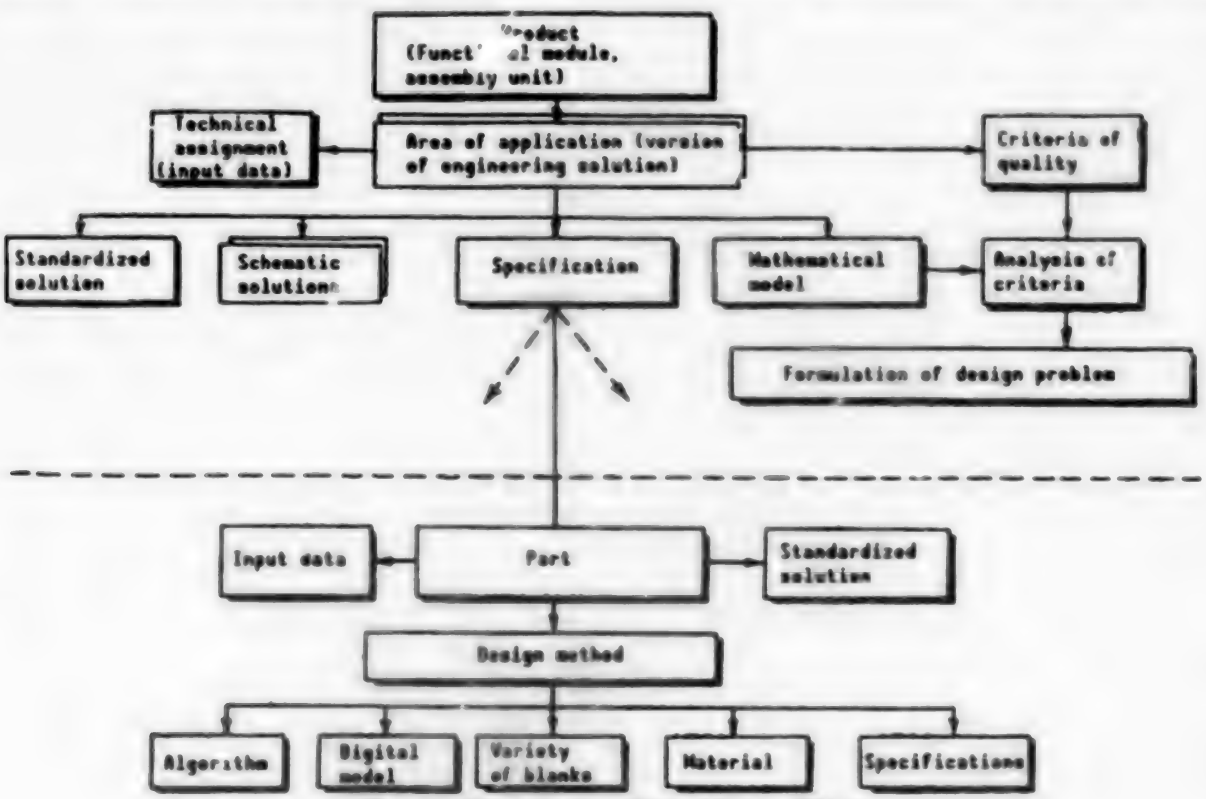



Figure 1. Diagram of Analysis of Design Object

life, vibration protection, impact resistance, standardization and unitization indicators, restriction of weight and overall dimensions, and design and technological requirements. This gradation of the technical assignment data with indication of the range of their variation is necessary to construct a unified hierarchical system of limits on the parameters of the product, which include, besides technical assignment data, the functional limitations, requirements of normative documents, limitations caused by the design and technological features of manufacture of assembly units and parts. Finally, the requirements of the technical assignment with respect to the composition and content of the output documentation at different stages of design are considered.

The mathematical model of the product, which is a system of mathematical functions that describe its status under different operating conditions, is studied from the viewpoint of the reliability and accuracy of description of the physical state of the product, the completeness of reflection of its internal and external relationships, the possibilities of numerical determination of all envisioned design parameters with respect to the technical assignment data. The methods are compiled on the basis of the general mathematical description: calculation of the main design parameters of the product, normalization of the input data for design of functional modules, formulation of schematic solutions, and check calculations. Moreover, the mathematical description of assembly units and parts at the following levels should reflect the empiricism of the designation of secondary design parameters, which are selected intuitively by the designer in the traditional approach, based on his experience.

The key parameters by which the element of a series is selected and the conditions of its conformity to the requirements of the technical assignment are established in the presence of the standardized solution of the product (standard size series). The range of values of the key parameters that permit the use of a standardized solution are also determined.

Specification of the functional modules is a list of assembly units; it actually reflects the consolidated composition of the product. Determination of the functional modules proceeds according to the following features: the need for the presence of a given module in the product, the specifics of its designation, the relative functional independence, the distinguishing features of the componentry, of the mathematical description and of the design principles. Along with determining the composition of the functional modules, the conditions of integrating them and the characteristics of formulating the schematic solutions of the product are analyzed. Parameters that influence the operation of the product as a whole and selection of the design parameters of other modules are determined for each module and differences in the composition of the product for different areas of application are determined.

The number and type of diagrams of the product are determined by its specifics. A number of diagrams, for example, functional, kinematic, and configurational, is worked out up to detailed development of the design. These diagrams in turn introduce additional restrictions on selection of the design solutions and parameters of assembly units and parts. Schematic diagrams (electrical, hydraulic and so on) are usually fulfilled after the design is detailed. The logic of designing the diagram should be reinforced by the corresponding method. The following aspects are considered when developing it: the qualitative composition and quantitative characteristics of the components of the diagram (componentry), their graphical and text notations, the design parameters of elements that influence the configuration of the diagram and which are reflected in its drawing, the conditions of integration of the elements, the rules and consequences of formulation of the diagram, and the requirements on formulation of it.

Formulation of the final goal of the design is closely related to the concept of the criteria of quality, which are the basis for comparison of the permissible variants of design solutions and adoption of the best of them. Selection of the criteria is individual for each product and is dependent on its operating conditions. For example, the minimum weight-size indicators and energy losses, the maximum speed, the minimum positioning error and so on may emerge, for example, as special criteria. A criterion which is a superposition of special criteria, taken with the corresponding coefficients, can be introduced for some products. The designation of criteria and normalization of the coefficients should be strictly substantiated, since they influence the selection of the design algorithm and its labor intensiveness. The criteria should meet the following general requirements: it should be of principal significance for evaluating the final results of design, it should be matched to the criteria of quality of the system, which includes the product, and it should be sensitive to variation of the design parameters of the product. The latter is studied through a mathematical model.

Ship machine-building products are constituent parts of more complicated objects—engineering complexes, ship systems, and of the ship as a whole. Their operating conditions and the characteristics of communicating with power supply and user systems are reflected in the technical assignment. Nevertheless, it is useful to have a consolidated mathematical model of the functioning of the product within the system. This is especially true of products operating under dynamic or cyclic loading conditions, elements of control systems, power plants, and also products that determine the specific use and main technical data of the ship. This model permits one to estimate the following: whether the technical data provide the efficiency of the system of the article to be designed in all modes, whether there are situations beyond the technical assignment which can critically affect the operation of the product within the system, whether the objectivity of the parameters of the product are reflected in the technical assignment, whether the system is sensitive to variation of the design characteristics of the product, whether the designation of the criteria

of quality of the product is valid from the viewpoint of the indicators of quality of this system as a whole, whether optimization of the parameters of the product to be designed is feasible and to what extent its results may affect the technical data and indicators of quality of the entire system. The results of this analysis may be reflected considerably in selection of the quality of criteria and of the design algorithm, and may result in overestimation of the degree of importance of individual types and results of work.

Formulation of the problem of design thus includes the goal, criteria of quality, system of constraints on the parameters of the product, the methods and means of reaching the goal (sequence, semantic content and technical support of the designer's actions). According to this, there is preliminary selection of the design algorithm, and the composition of the digital model of the design is determined.

The lowest levels of the product are studied according to the described scheme. The differences are manifested in formulation of the input data for design of assembly units and parts and upon the appearance of extra design relationships. If the product has a clearly marked tree-like hierarchical structure, the input data for design of any of its elements are completely determined by the data of the technical assignment and by the design solution of the element of higher level, within which it is included. The input data for design of assembly units and parts is normalized "from the top down" and is deterministic in nature. If there is feedback that characterizes the influence of the parameters of the element to be designed on selection of the parameters and even the design solution of elements of higher levels, normalization of the input data becomes ambiguous. This ambiguity can be resolved by two methods: by cyclic organization of the design process, directed toward sequential refinement of the technical solutions that eliminate an error of the parameters of interconnected elements, or by extensive additional study of the object to determine known positive solutions that guarantee matching of the parameters of the elements at all levels. Both methods have their own advantages and disadvantages. One of them should be selected for a specific application with regard to the efficiency of organizing the computing process.

The componentry, which is a list of the standardized assembly units and parts to be used during design, makeup elements, materials and grades of blanks with indication of the key parameters for selection of the necessary standard dimensions and restrictions on their use, is formulated in parallel with analysis of the object.

The design process is studied in the diagram shown in Figure 2 for each specific area of application of the product, if this is reflected in the composition and sequence of the procedures. The process as a whole and its attributes are considered at the highest level, the design procedures which represent combinations of work having a common subject or problem direction is considered at the next level, and the elementary jobs and

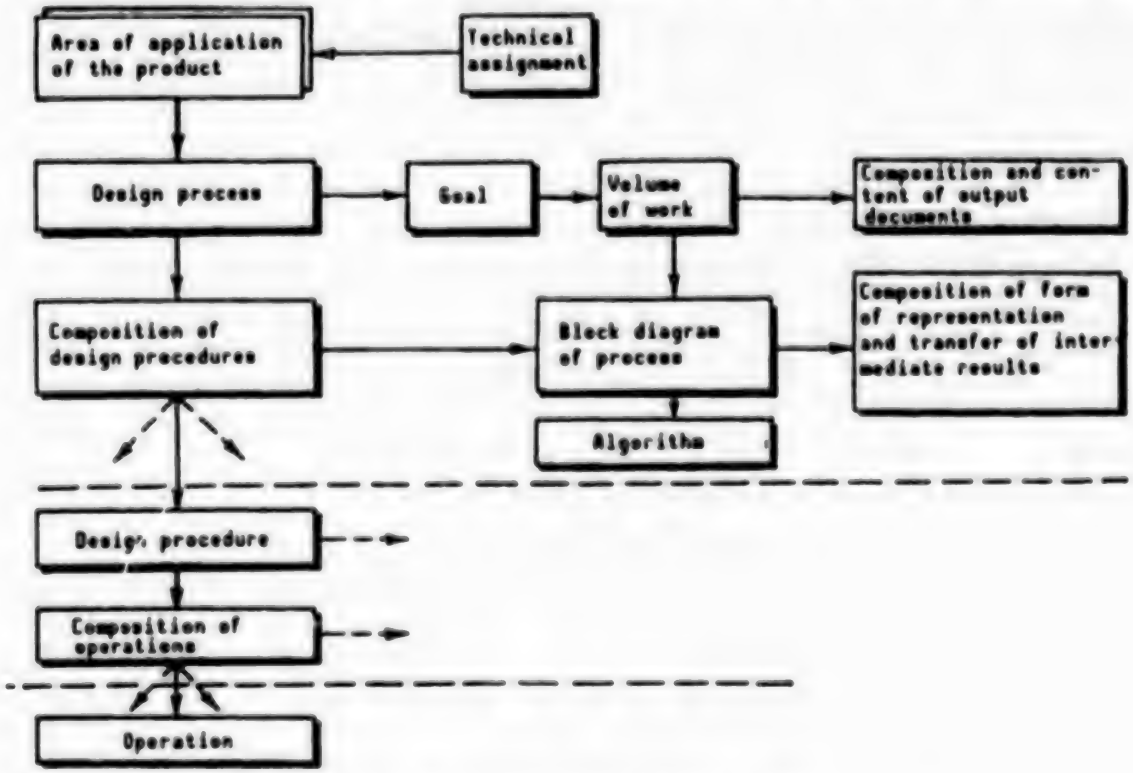



Figure 2. Diagram of Analysis of Design Process

operations included in the procedure are considered at the lowest level. The order of study of the process at all three levels is essentially identical. Its attributes—the goal of design, the composition and content of output documents, mathematical models and methods—are considered upon analysis of the design object. The composition of procedures is a list of the combinations of jobs which make up the design process.

The procedures are determined on the principle of the subject or problem orientation or the papers contained in them, directed toward solution of a relatively independent design problem, of the originality or the methods and models to be used, and of the significance of the result for developing the design of the product. The block diagram reflects the relationships between the procedures and sequence of executing them. The logical conditions of the beginning, normal and abnormal end of the process, transition from procedure to procedure, and the order of accumulation of the results and checking of their completeness and quality are considered. The data flows between procedures and operations (input, reference and output data, procedures, sources and users of data) are additionally analyzed for the two bottom levels. A list of the mathematical models and methods is presented in the sequence envisioned by the logic of executing the procedure or operation. The data flows at all hierarchical levels should be fully matched as a result of study of the design process.

The work to order the designer's database includes study of the object and the process of design. The data can be divided into permanent and temporary (or online) by the nature of use. Permanent data include reference-information data, archive, normative, operating data, the parameters of physical processes, notations and requirements on formulation of drawings, and text documents. They are corrected only if there are changes made in the normative documents or if the archive is expanded or operational statistics are accumulated. Online data are used only in developing the current design. They include: data of the technical assignment, general design parameters, service information on the status of the design, intermediate and final results of design of the product and of its elements. The composition and organizational scheme of online data, the order of data transfer during design and making changes in the database are dependent on the type and structure of the product and on the algorithm for computer-aided design of it.

Thus, the result of the first phase is a block diagram and ordered mathematical description of the object, a detailed diagram of organization of the design process (the design algorithm), and the composition and structure of the information base.

The concept of the CAD system is refined on the basis of these materials and the composition of the components of the software and hardware is determined. The concept of the CAD system should reflect its functional and structural solution with regard to the general of development of automated systems at the enterprise, which takes into account the specifics of the potential objects of design, of the composition of the hardware and its basic software, the presence of universal program products that permit adaptation within the CAD system to be developed, and the requirements on its coordination with other automated systems contained in the integrated manufacturing system.[3,4] The most significant work of the second phase is selecting the means of information servicing of the design process, interactive interaction of the user and computer, graphics service, and documentation or preparation of the technical assignment for development of them. Moreover, an important aspect is working out the organizational structure of the enterprise under conditions of functioning of the CAD system.

Naturally the phase of formalization of the design problem is necessary, since the computer operates only with symbolic data, which requires switching from cognitive description of the problem in the language of traditional engineering concepts to symbolic-logic interpretation of it, convenient for compilation of a machine program. Regardless of the specifics of the semantic content of the problem, one can point out rather common procedures of formalizing it. The process of formalization of the design problem includes: 1) determination of the composition of the design subsystems of the CAD system that realize the selected algorithm and formal representation of it in the form of a block diagram (or graph) of the interaction of the subsystems with indication of the conditions of access to each of them, normal and abnormal completion of its work; 2) coding of traditional engineering concepts which reflect the types, forms, and features of the design version, standard dimensions of the assembly units and parts that comprise the componentry of the product, design situations, and results of design; 3) mathematical description of the logic of reaching engineering solutions; 4) formulation of generalized calculating schemes and logic conditions of obtaining on their basis a mathematical description of the modified technical solutions to be used in specific applications; and 5) coding of the description of the data tables, standard queries, control instructions of the input-output processes, editing and display of information with regard to requirements which impose the use of earlier developed universal software.

Development of a CAD system as a program system is related to solution of its own type of optimization problem to determine its rational structure, diagrams of interaction of the design and service subsystems, organization of data transfer, which realize the selected design algorithm. The criterion of quality is the minimum expenditures of labor, material and time resources in fulfilling the design through automation. This criterion is transformed in practice into special requirements: reduction of the number of iterations of the process of formulation of the technical solutions on the product as

a whole and on its fragments, rational distribution of computer resources, convenience and speed of access to data, simplicity of working with the system, and support of its high reliability.

During formalization, the selected design algorithm may undergo significant changes, caused by the following reasons. First, the ineffectiveness of algorithmic solution of the design problem for many practical applications, which envisions iterative improvement of the adopted technical solutions for the product and fragments of it. The most rational alternative here may be the designer's subjective decision with respect to the need to carry out further iterations, selection of the parameters to be varied, the steps of changing them, and the intermediate results of designs which he adopts during analysis. Greatest attention should be devoted to effective organization of interaction of the user and computer, to diagnostics and clearness of representation of the design results, and to expansion of the information service. Second, it may be caused by the possibility of using standardized program modules for design of assembly units and parts included in functional modules, different by designation and technical solution.

The simplest design algorithm is formalized for products with tree-like hierarchical structure. It may be constructed in the form of a sequence of design procedures, each of which realizes the check of the conformity of a set of possible technical solutions of a product or of its element to the next hierarchical step of the system of constraints, which was discussed earlier. Checks are made in the order of a decrease of the degree of influence of the constraints on the final results of design. Possible solutions that satisfy the entire system of constraints are considered permissible. Comparative analysis of them is conducted during the final phase of design from the aspect of introduced quality of criteria. This automated design algorithm is realized, for example, in a CAD system for hydraulic drives.[5] The design algorithm should generally envision a number of iterations, directed toward sequential improvement of the technical solutions and interagreement of the parameters of related assembly units and parts with the network structure of the product and in the presence of feedback.

The design of most ship machine-building products, regardless of their class, composition of the component base, and structural solution can be reduced to the following formal scheme: analysis of the technical assignment and determination of the composition of the functional elements that ensure the efficiency of the product, analysis of its operating cycle, formulation of the input data for design of assembly units and parts, sequential or parallel design development of assembly units, matching of the parameters of related assembly units, and modification of technical solutions and output of design documentation. It is this scheme that can be used when determining the composition and order of interaction of the design subsystems of CAD systems. For example, the subsystem "Operating cycle" for the elements of power plants should include programs of thermodynamic and gas dynamic calculations of the thermal cycles. The subsystem for control systems and tracking drives should include programs for analysis of the stability and transient processes, and that for hoist-transport elements should include programs for development of the kinematic scheme with elements of power calculation. The programs should determine the optimal (rational) parameters of the product, the range of their permissible deviation from optimal values, formulation of input data (special technical assignments) for design of functional modules. Further, based on the characteristics of the design solutions of the product and of its component base, there is determination of subsystems that support design of original functional modules. The extent of design development by using these object-oriented subsystems can be different.

The design subsystems may encompass the entire cycle of design, up to formulation and output of text and graphics documents, for modules having a low level of standardization and unitization of the makeup assembly units and parts. If standardized technical solutions are used in the modules, the functions of the corresponding design subsystems of the general configuration of the module can be limited by compilation of its specification, by development of schematic solutions, by determination of the rated values of the parameters of standardized assembly units and parts, detailed design development of which can be carried out through problem-oriented design subsystems. These subsystems are specialized on specific types of assembly units and parts or on fulfillment of standard design operations. An example of these standardized designs may be hydraulic drives, the blade apparatus of turbomechanisms, reduction gears, shafting, bearing assemblies, and cable-feed mechanisms.

It should be noted in conclusion that any standardization, including that in development of a CAD system, by supporting the corresponding effect in the sphere of design, should not limit the designer for a creative search for new original engineering solutions.

**Bibliography**

1. Jones, D. K., "Metody proyektirovaniya" [Methods of Design], Moscow, Izdatelstvo "Mir," 1986.

2. Nikolayev, V. I. and V. M. Bruk, "Sistemotekhnika: metody i prilozheniya" [Systems Engineering: Methods and Applications], Leningrad Izdatelstvo "Mashinostroyeniye," 1985.

3. "Avtomatizirovannoye proyektirovaniye i proizvodstvo v mashinostroyenii" [Computer-Aided Design and Manufacturing in Machine Building], edited by Yu. M. Solomentsev and V. G. Mitrofanov, Moscow, Izdatelstvo "Mashinostroyeniye," 1986.

4. "Informatsionnoye obespecheniye integrirovannykh proizvodstvennykh kompleksov" [Database Management and Support of Integrated Manufacturing Systems], edited by V. V. Aleksandrov, Leningrad, Izdatelstvo "Mashinostroyeniye," 1986.

5. "Sistemy avtomatizirovannogo proyektirovaniya izdeliy i tekhnologicheskikh protsessov v mashinostroyenii" [Computer-Aided Design Systems for Products and Production Processes in Machine Building], edited by R. A. Allik, Leningrad, Izdatelstvo "Mashinostroyeniye," 1986.



UDC 621.383:681.34.021

## Fast Coordinate Transformation Unit for Electrophysical Scanning Devices

*18610318h Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian*
*No 5, Sep-Oct 88 pp 187-191*

[Abstract of article by N.T. Danilchenko and L.N. Lozovoy, Burevestnik NPO, Leningrad; submitted 31 July 87]

[Abstract] A unit has been designed for fast transformation of the polar-coordinate data (either in analog or digital form) from scanning spectrometers, electrostatic analyzers, etc., into the rectangular coordinates needed for output to a flatbed plotter. Block diagrams of the unit, and of its trigonometric, multiplication, and control/synchronization modules, are adduced. For uniform time gating (which maximally simplifies the code transforming circuits) and a 1 MHz clock rate, the unit can perform around $3 \times 10^4$ op/sec; for nonuniform gating and a maximum clock rate of 10 MHz, this increases to roughly $10^5$ op/sec. Faster operation is possible by using the faster K1802 microprocessor in the code multiplier. The unit as developed here is incorporated in the TAIR (technological analyzer of x-ray pulses) device for determining the boundary between two media of different densities, which was put into series production in early 1988. Figures 4, tables 2, references: 5 Russian.

UDC 681.527.7

## Multi-Channel Programmable Control Unit

*18610318i Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian*
*No 5, Sep-Oct 88 pp 191-192*

[Abstract of article by A.S. Kolesnikov, Applied Microbiology SRI (A-U) in Obolensk, Moscow oblast; submitted 10 Aug 88]

[Abstract] A ten-channel timer/controller is described for sequentially switching on external devices in from 1 to 9 different programmable closed cycles. Each channel (corresponding to a different external device) can be programmed to operate in one of the following time intervals: 0.1-9.9 s, 1-99 s, 1-99 min or 1-99 h. Thyristor switches and relays are employed in the output circuit of each channel. The unit requires +5 v. Figures 1, references: 1 Russian.

UDC 621.385.833(088.8)

## Digital Current Regulator for Automatic Control Systems

*18610318j Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian*
*No 5, Sep-Oct 88 pp 193-194*

[Abstract of article by Ye.P. Bocharov, V.A. Polyarskiy and P.A. Stoyanov; submitted 21 Sep 87]

[Abstract] This article describes two types of digital current regulator designed by the authors for control of the magnetic lens, stigmator and other electron-optical control elements of the SVEM-1 super-high-voltage electron microscope. The basic design uses shaft position encoding by passing light through code-forming openings where it is detected by photodiodes which pass on a signal to the control circuits. In one variant the code openings are in concentric shafts, in the other they are on disks fastened to the shafts. The encoding schemes are described in some detail. Figures 2, references: 1 Russian.

UDC 621.396.669

## Device for Electron Beam Current Control

*18610318k Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian*
*No 5, Sep-Oct 88 pp 202-203*

[Abstract of article by A.I. Balabukh, V.N. Kiselev, M.N. Leshchev and Ye. G. Livshits, Leningrad Electrical Engineering Institute; submitted 11 May 87]

[Abstract] A device is described for controlling the voltage to the cathode of a triode-based electron beam gun (and hence the charged particle current in that beam). It is based on a high-frequency voltage converter/inverter which maintains a 60 kV isolation between primary and secondary windings by virtue of a teflon-like housing; the voltage frequency at the secondary winding is 32 kHz, which acts as a carrier frequency for the controlling pulse. The voltage to the cathode may be varied over the range 0 to 2.5 kV with smooth increases/decreases in beam current over 0.01 to 10 s intervals; or the system can damp output voltage instabilities of as little as $10^{-4}$. This device is currently being utilized in the UVL-3009 industrial intermediate-vacuum welding installation. Figures 1.

UDC 542.953/954

**Evaporator for Synthesizing Thin Films in Vacuum**

*18610318l Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian*
*No 5, Sep-Oct 88 pp 203-205*

[Abstract of article by K.K. Muravyeva, M.D. Voronov and V.P. Rubets, Leningrad Technological Institute; submitted 15 Jul 87]

[Abstract] The disadvantage of most current designs in evaporators with semi-enclosed volumes is that, due to technical difficulties, they have no plugs or flanges that can be put into place to separate the evaporation and condensation volumes. This makes it difficult to maintain the proper growth conditions for, in particular, thin films (100 to 10 nm and less). An evaporator has been designed that addresses this shortcoming, with an internal stopper controlled by an electromagnet. This arrangement avoids transient processes at the beginning and end of the synthesis of films and film-like heterostructures, allowing us to register the time of synthesis to within 0.25 s. The evaporator was tested in a study of the growth of 10 to 30 nm-thick CdTe epitaxial films in a vacuum of $3 \times 10^{-3}$ Pa and semi-enclosed reaction volume of 5 to 6 $cm^2$ at a temperature of 400 to 500 °C. Electron microphotographs of the initial stages of the process are adduced. Figures 3, references: 5 Russian.

Foreign Broadcast Information Service (FBIS) and Joint Publications Research Service (JPRS) publications contain political, economic, military, and sociological news, commentary, and other information, as well as scientific and technical data and reports. All information has been obtained from foreign radio and television broadcasts, news agency transmissions, newspapers, books, and periodicals. Items generally are processed from the first or best available source; it should not be inferred that they have been disseminated only in the medium, in the language, or to the area indicated. Items from foreign language sources are translated; those from English-language sources are transcribed, with personal and place names rendered in accordance with FBIS transliteration style.

Headlines, editorial reports, and material enclosed in brackets [ ] are supplied by FBIS/JPRS. Processing indicators such as [Text] or [Excerpts] in the first line of each item indicate how the information was processed from the original. Unfamiliar names rendered phonetically are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear from the original source but have been supplied as appropriate to the context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by the source. Passages in boldface or italics are as published.

## SUBSCRIPTION/PROCUREMENT INFORMATION

The FBIS DAILY REPORT contains current news and information and is published Monday through Friday in eight volumes: China, East Europe, Soviet Union, East Asia, Near East & South Asia, Sub-Saharan Africa, Latin America, and West Europe. Supplements to the DAILY REPORTs may also be available periodically and will be distributed to regular DAILY REPORT subscribers. JPRS publications, which include approximately 50 regional, worldwide, and topical reports, generally contain less time-sensitive information and are published periodically.

Current DAILY REPORTs and JPRS publications are listed in *Government Reports Announcements* issued semimonthly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161 and the *Monthly Catalog of U.S. Government Publications* issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The public may subscribe to either hardcover or microfiche versions of the DAILY REPORTs and JPRS publications through NTIS at the above address or by calling (703) 487-4630. Subscription rates will be provided by NTIS upon request. Subscriptions are available outside the United States from NTIS or appointed foreign dealers. New subscribers should expect a 30-day delay in receipt of the first issue.

U.S. Government offices may obtain subscriptions to the DAILY REPORTs or JPRS publications (hardcover or microfiche) at no charge through their sponsoring organizations. For additional information or assistance, call FBIS, (202) 338-6735,or write to P.O. Box 2604, Washington, D.C. 20013. Department of Defense consumers are required to submit requests through appropriate command validation channels to DIA, RTS-2C, Washington, D.C. 20301. (Telephone: (202) 373-3771, Autovon: 243-3771.)

Back issues or single copies of the DAILY REPORTs and JPRS publications are not available. Both the DAILY REPORTs and the JPRS publications are on file for public reference at the Library of Congress and at many Federal Depository Libraries. Reference copies may also be seen at many public and university libraries throughout the United States.

END OF

FICHE

DATE FILMED

22 MAY 89